NC 05545 Genetic Investigation of Tobacco and the *Nicotiana* Species

V. A. Sisson

I. Summary of Research:

A. Leaf Chemistry of the *Nicotiana* Species

Interspecific hybridization has been demonstrated to be a useful tool in the transfer of disease-resistant traits for improving tobacco cultivars. The same success is believed possible with respect to altering the chemical profile of commercial tobacco. However, before a program of interspecific hybridization is considered, it is necessary to carefully assay the *Nicotiana* species for their chemical constituents.

All of the *Nicotiana* species for which seed stocks exist, 66 in all, were grown in the greenhouse during the summers of 1983 and 1984. At flowering two different samples were taken. To study leaf surface chemistry, leaves were dipped several times in methylene chloride. This leaf wash was analysed for diterpenes, fatty alcohols, hydrocarbons, and sucrose esters. The second sample consisted of green leaf lamina to determine internal leaf constituents including alkaloids and other nitrogenous constituents, sugars, polyphenols, and organic acids. This latter sample was freeze dried and ground to a fine powder for analysis. Only results from 1983 are complete.

All of the *Nicotiana* species were found to contain alkaloids, reinforcing the claim that alkaloids are a characteristic feature of the genus. Total alkaloid levels among the *Nicotiana* species ranged from a low of 0.01% to a high of 2.38%. In general, alkaloid levels for the species were low with more than 50 percent of the species having levels below 0.25% compared to an overall mean of 0.43%. All of the species contained two or more of the nicotine alkaloids; however, a single alkaloid tended to predominate in a given species. Nicotine and nornicotine were found in all 66 species. Anabasine was produced in 65 species; anatabine occurred in 56 species; while myosmine was detected in only five species. Nicotine was the major alkaloid produced in 34 species, nornicotine was the predominant alkaloid in 19 species, and anabasine was produced in the greatest quantity in 4 species. Alkaloid levels and composition appeared somewhat similar within taxonomic sections, although numerous exceptions were found.

A wide variation in total polyphenol content was observed among the species, from a low of 0.4% (d.w.) in *N. cordifolia* to a high of 6.0% in *N. tomentosiformis*. Total chlorogenic acid content varied from 0.26% (*N. acaulis*) to 5.35% (*N. tomentosiformis*). Although all species produced chlorogenic acid, different isomer distributions were observed. Rutin content of the species was also observed to vary widely. In addition, several species contained major quantities of unknown polyphenols. No apparent association among polyphenol content or composition was observed among taxonomic groupings.

The green leaf cuticular chemistry of the species was analysed by glass capillary gas chromatography (GC-2). These GC-2 profiles were highly variable as expected. In general, the profiles for diterpene, fatty alcohol, hydrocarbon, and sucrose ester fractions were similar within taxonomic sections; however, quantitative differences were characteristic of each profile. Leaf surface chemistry provided supportive evidence on the origin of several species. For example, N. sylvestris and N. tomentosiformis have been reported to be the putative progenitors of N. tabacum. N. sylvestris was the only species found to produce high levels of duvanes (α- and β-4,8,13-duvatriene-1,3-diols and α- and β-4,8,13-duvatriene-1-ols) also characteristic of N. tabacum. N. tomentosiformis produced cis-abienol and other labdane diterpenes and sucrose esters containing β-methylvaleric acid moieties similar to those found in Oriental tobaccos. Both species produced cuticular hydrocarbon and fatty alcohol fractions similar to N. tabacum. The results of this work are highly desirable for genetic and evolutionary analyses as well as the practical significance of identifying potentially useful germplasm for tobacco improvement.

B. Introgression of Genes for Disease Resistance

An interspecific hybridization program has been initiated to transfer root knot nematode resistance from N. tomentosa (acc. 58) into N. tabacum germplasm. Resistance from this species would serve as an alternate source of resistance to that currently available in commercial cultivars. This later source of resistance has been shown to be associated with susceptibility to potato virus Y (PVY). N. tomentosa is not only resistant to the root knot nematode but shows immunity to PVY.

The initial F1 hybrid plants between an autotetraploid derivative of 'NC 2326' and N. tomentosa were all root knot resistant. Although the F1 plants were highly sterile, a few backcross seeds were obtained. The BC1 progeny segregated in an approximate 1:1 ratio of resistant and susceptible plants. Among the BC2 progeny several resistant plants were identified which had fertility partially restored. Recently, 89 BC3F1 plants were tested and 49 plants were found that were completely free of root knot nematodes. Backcrossing and selection will be continued and root knot resistant selections will be tested for resistance to PVY.

C. Use of Isozyme Markers in Genetic Investigations of Tobacco

The feasibility of using isozymes as genetic markers in detecting variability arising in anther-derived doubled haploids from an inbred source was examined. Diploids, anther-derived haploid and doubled haploids were analysed for six different isozyme systems using horizontal starch gel electrophoresis. Field tests identified several doubled haploid lines with significantly reduced agronomic performance relative to the anther source material. Although differences in zymograms were detected, these differences could not be associated with the anther-derived lines. The failure to find isozyme differences among these materials does not preclude the utility of this test. Additional isozyme systems will be examined in this material in the future.

D. Development of Insect Resistant Germplasm

A program to develop flue-cured germplasm with insect resistance was continued. A population of about 400 doubled haploids was evaluated this past year for resistance to the tobacco budworm and for flue-cured plant type. High levels of resistance were found in a number of lines; however, only one of the resistant lines had an acceptable plant type. Additional backcrosses and selections are underway.

II. Publications:

Chaplin, J. F. and V. A. Sisson. 1984. Interspecific hybridization between N. rustica and N. tabacum for different alkaloid levels. (Abstr.) CORESTA Information Bulletin - 8th Intn. Tob. Sci. Cong. pp. 93-94.

Severson, R. F., R. F. Arrendale, L. B. Smith, K. L. McDuffie, and V. A. Sisson. 1984. Green leaf cuticular chemistry of Nicotiana species. (Abstr.) 38th Tobacco Chemists' Research Conference. p. 7.

Sisson, V. A. 1984. Osozyme profiles from anther-derived haploid and doubled-haploid tobacco lines. (Abstr.) 1984 Agronomy Abstracts, Amer. Soc. Agron., Madison, WI. p. 88.

Sisson, V. A. and R. F. Severson. 1984. Alkaloid composition of the Nicotiana species. (Abstr.) 38th Tobacco Chemists' Research Conference. p. 13.

Snook, M. E., O. T. Chortyk and V. A. Sisson. 1984. Polyphenols in Nicotiana species. (Abstr.) 38th Tobacco Chemists' Research Conference. p. 14.

III. Manuscripts Accepted for Publication:

Lax, A. R., K. C. Vaughn, V. A. Sisson and G. E. Templeton. 1985. Ferredoxin-NADP$^+$ reductase, a nuclearly-coded enzyme unaffected by tentoxin treatment. Photosynthesis Research.

IV. Papers Presented at Professional Meetings

Sisson, V. A. Isozyme profiles from anther-derived haploid and doubled-haploid tobacco lines. Annual Meeting of the Crop Science Society of America. Los Vegas, NE. November, 1984.

Sisson, V. A. The use of isozymes in tobacco breeding and genetics. 31st Tobacco Workers' Conference. Pinehurst, NC. January, 1985.

Sisson, V. A. and R. F. Severson. Alkaloid composition of the Nicotiana species. 38th Tobacco Chemists' Research Conference. Atlanta, GA. October, 1984.

V. Acknowledgements:

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Title: NC 05524 Development and Evaluation of New Sources of Nicotiana Germplasm

Project Leader(s): Sandra M. Reed

I. Summary of Research:

A. Cross-restoration of N. tabacum cms lines

Cytoplasmic male-sterility (cms) frequently occurs following interspecific hybridization in Nicotiana. The interaction of N. tabacum chromosomes with alien species cytoplasm often results in the formation of flowers that are functionally or structurally male-sterile. Complete or partial restoration of fertility has been observed in five of the Nicotiana cms lines as the result of the addition of an alien species chromosome. While not all of the chromosomes of an alien species are capable of restoring fertility, it is not yet known if more than one of the chromosomes can restore fertility or if fertility restoration is specific to just one chromosome in the alien species genome. In addition, the interaction between an alien cytoplasm and a restorer chromosome from a third Nicotiana species has not been investigated. The purpose of this study was to address this question of cross-restoration among various Nicotiana cms and cms-restored lines. Five cms lines were pollinated by four cms restored lines. The sources of cytoplasm in the cms lines were N. repanda, N. bigelovii, N. undulata, N. suaveolens and N. debneyi. Restored lines of all of these sources except N. debneyi were used as the pollinators. The N. debneyi cytoplasm restored line was omitted from the study because it does not produce viable pollen. Homozygous restored lines were used in the crosses to insure that each of the progeny would receive a restorer chromosome.

Only two of the crosses resulted in complete fertility restoration in the progeny. Complete fertility was restored to the N. repanda cms line by the N. suaveolens restorer and to the N. suaveolens cms line by the N. repanda restorer. The N. bigelovii restorer was much more effective in restoring fertility to the N. debneyi cms line than was the N. debneyi restorer. While the N. debneyi restorer affects only flower morphology, the presence of the N. bigelovii restorer resulted in the production of approximately 25% viable pollen. In four of the crosses, small improvements in flower morphology or pollen production were noted; however, these were too small and variable to be termed even partial restoration. No cross-restoration effect was observed in the remaining 9 crosses.

B. In vitro resistance to blue mold (with R.C. Rufty)

A study to determine if resistance to blue mold (Peronospora tabacina) is expressed in callus cultures of Nicotiana was conducted. The reaction of calli of the N. tabacum cultivars Ky 17, McNair 944, Z-3 and Ovens 62 and of the wild species N. debneyi to in vitro infection by P. tabacina was tested. Ky 17 and McNair 944 are classified as blue mold susceptible, while the other two N. tabacum cultivars are considered to be resistant. N.

debneyi is highly resistant to P. tabacina at the whole plant level.

Callus cultures of the five genotypes were initiated from cotyledons. Calli were inoculated with P. tabacina approximately 14 weeks and 5 subcultures after callus initiation. Blue mold infected "Virgin A Mutant" tobacco plants were used as the source of inoculum. Heavily sporulating leaf tissue was cut into 1 cm^2 pieces which were mounted to the inside of the lids of the petri dishes containing the calli. The lids were replaced with fresh lids after 16 hours. The cultures were then sealed and placed in a 23°C incubator.

Cultures were scored for infection 10 days after inoculation. Calli were examined under a stereomicroscope to determine the amount of mycelia present. Ratings were on a scale of 1 (no infection) to 5 (heavy infection).

Plants of the four N. tabacum cultivars were also inoculated with blue mold to determine the relative degree of resistance or susceptibility of each genotype at the whole plant level. Plants were again rated on a scale of 1 to 5.

All of the genotypes were infected by P. tabacina in vitro. Averaged over 3 trials the percentage of infected cultures for each genotype were: N. debneyi, 64%; Ovens 62, 63%; Ky 17, 51%; Z-3, 20%; and McNair 944, 16%. It was concluded that if resistance to blue mold is present at the cellular level it must be expressed in some way other than a lack of infection of callus. Therefore, the disease index of the cultures was analyzed to determine if differences in amount of mycelial colonization of the calli exist between resistant and susceptible genotypes. The analysis of variance was calculated using only the ratings of the infected cultures. The non-infected cultures were considered to be the result of escape rather than resistance and therefore were eliminated from the analysis.

A highly significant effect due to genotype and a significant effect due to the genotype by trial intuation was found in the analysis of the disease index data. The general ranking of the lines, in order of descending degree of in vitro infection, is Ovens 62, Ky 17, N. debneyi, Z-3 and McNair 944 (Table 1). This ranking does not correspond to the ranking of whole plant resistance (Table 1). Therefore, it was concluded that the genotypic differences in in vitro infection that were observed are not related to the resistance or susceptibility of the genotypes at the whole plant level. Consequently, it appears that in vitro screening of tobacco genotypes for resistance to blue mold is not a feasible alternative to disease screening at the whole plant level.

C. Production of nullisomics of N. tabacum (with M.G. Kramer)

Aneuploid stocks of cultivated plants are valuable resources for genetic studies. While the complete set of 24 monosomics (2n-1) of N. tabacum are available, only 5 of the 24 N. tabacum nullisomics (2n-2) have been obtained. The purpose of this study is to attempt to complete the

N. tabacum nullisomic collection.

Two procedures are being used to produce the nullisomics. First, the N. tabacum monosomics are being pollinated with N. africana. Four types of progeny are expected from each of these crosses: lethal interspecific hybrids, aneuploid hybrids, euhaploids (n=24) and nullihaploids (n=23). Using morphological and cytological data, the nullihaploids can be identified. Chromosome doubling will then yield nullisomics. Currently, approximately 10 monosomic x N. africana crosses have been made for each monosomic. These crosses are being seeded and nullihaploids, if present, should be identified in the next few months.

The other procedure that is being tested involves the use of irradiated pollen of N. glutinosa. When pollen of N. glutinosa that has been exposed to at least 50-75 krad of gamma-irradiation is used to pollinate N. tabacum, haploids are produced. When a tobacco monosomic is used in the cross, haploids and nullihaploids are expected. A number of crosses between six of the N. tabacum monosomics (Monosomics F,H,L,M,P and R) and irradiated N. glutinosa have been made. Chromosome counts are currently underway to identify nullihaploids among the progeny. Once identified, chromosome number will be doubled to produce nullisomics.

II. Graduate Students:

Maria G. Kramer. M.S. Production of Nullisomics of N. tabacum.

V. Manuscripts Accepted for Publication:

Reed, S.M. and R.C. Rufty. 1985. Reaction of callus of blue mold resistant and susceptible Nicotiana genotypes to infection by Peronospora tabacina. Tob. Sci. (in press).

VII. Papers Presented at Professional Meetings

Reed, S.M. and R.C. Rufty. Reaction of callus of susceptible and resistant cultivars of N. tabacum to Peronospora tabacina. 31st Tobacco Workers Conference. Pinehurst, N.C. January 1985.

Table 1. Disease Index of *Nicotiana* callus cultures and whole plants infected by *P. tabacina*

	Disease Index (Mean of 3 trials)	
Genotype	Callus cultures	Whole plants
Ovens 62	3.2	2.0
Ky 17	3.0	4.6
N. debneyi	2.9	---
Z-3	2.8	3.1
McNair 944	2.2	4.7

CROP SCIENCE

Varietal Evaluation Studies in Flue-Cured Tobacco

Daryl Bowman

I. A. N. C. Official Variety Test - Tobacco (1984)

Twenty-six released varieties and 26 experimental lines were tested at five locations. Included in the experimentals were eight entries of the Regional Farm Test. NC 95 and NC 2326 were included as standards in these tests.

Up-to-date information is available on the performance of these varieties in the results of the North Carolina Official Variety Research Report No. 97, dated December 1984 from experiments conducted in 1984. The test locations represent growing conditions in the Border, Eastern, Middle and Old Belts in North Carolina. Research Report No. 97 serves as a guide in helping growers choose their 1985 varieties for planting. Copies of this report are mailed to county extension chairmen, seedsmen, and agri-business representatives.

Combined data from the 1984 trials from four locations are shown in Table 1.

B. Regional Minimum Standards Program

The first phase of the Regional Minimum Standards Program consists of the Regional Small Plot Tests which are located on tobacco experiment stations in the flue-cured region. In North Carolina the tests are located at the Border Belt Tobacco Research Station, Lower Coastal Plain Tobacco Research Station and the Oxford Tobacco Research Station.

In 1984, forty entries were included in the Regional Small Plot Test, along with the two standards--NC 2326 and NC 95. A separate publication giving individual location data and combined data for six locations has been distributed to all committee members and other interested parties. Sixteen lines met the minimum standards in the Regional Small Plot Test and may be advanced to the Regional Farm Test in 1985.

The Regional Farm Test is the final phase of the Regional Minimum Standards Program and in 1984 contained eight lines which were evaluated under code by the Variety Evaluation Subcommittee of the Flue-Cured Tobacco Quality Committee. Four of these breeding lines met the minimum standards. The lines were Coker 82-211Y, NK 2117, PD 279, and VA 102. These have been evaluated for two years in the Regional Small Plot Test and one year in the Regional Farm Test and have met the standards as prescribed. This makes 73 entries that have met the minimum standards since this program was developed. Seed of these four lines may be available for 1986 plantings should the breeder or agency

decide to increase the seed. Data from the Regional Farm Test are published annually in the Flue-Cured Tobacco Variety Evaluation Committee Report.

II. A. Unclassified Graduate Student

Mr. Abdel Bary

B. R. J. Reynolds Undergraduate Apprentice

Mr. Glenn Stocks

IV. Publications

Bowman, Daryl, Tom Corbin and Glenn Tart. "Measured Crop Performance Tobacco 1984." Research Report No. 97, December, 1984.

Bowman, D. T., E. A. Wernsman, T. C. Corbin, and A. G. Tart. 1984. Contribution of Genetics and Production Technology to Long-Term Yield and Quality Gains in Flue-Cured Tobacco. Tob. Sci. 28:30-35.

V. Manuscripts Released for Publication

Bowman, D. T., E. A. Wernsman, T. C. Corbin, and A. G. Tart. Performance of four Maryland tobacco cultivars under two different harvest schemes in North Carolina. Tob. Sci. (In Press).

Bowman, D. T., and J. O. Rawlings. An empirical method of establishing chemical standards for flue-cured tobacco. Tob. Sci. (In Press).

VII. Papers Presented at Professional Meetings

Bowman, D. T., T. C. Corbin, and A. G. Tart. 1985. Resource allocation for North Carolina flue-cured tobacco OVT. 1985 Tobacco Workers' Conference, Pinehurst, NC.

NORTH CAROLINA OFFICIAL VARIETY TESTS
COMPARISON OF VARIETIES IN 1984 FOR CERTAIN CHARACTERISTICS
COMBINED FOR FOUR LOCATIONS: WHITEVILLE, KINSTON, ROCKY MOUNT, AND OXFORD

Table 1.

Variety	Grade Index	Value Index $/Cwt.	Value Index $/A	Yield Lbs/A	Days to Flower	Leaves per Plant	Plant Height Inches	Ground Suckers	Cured Leaf Analysis Red. Sug.	Cured Leaf Analysis Tot. Alk.	Cured Leaf Analysis Sug. Alk.
NC 2326	53	180.63	4870	2688	63	17.6	43	0.1	17.77	2.54	7.89
NC 95	50	179.39	5015	2788	67	18.9	41	0.8	18.25	2.75	6.97
Clemson PD4	51	180.85	5474	3018	71	19.2	44	0.1	18.98	2.40	9.06
Coker 48	49	179.31	5473	3049	70	19.7	45	0.7	18.15	2.69	7.30
Coker 176	54	181.30	5109	2810	71	20.2	42	0.4	17.62	2.96	6.20
Coker 206	56	181.43	5383	2958	70	18.9	41	0.2	15.20	3.11	5.53
Coker 209	52	180.08	4920	2728	73	22.4	44	0.1	16.75	2.92	6.19
Coker 298	53	179.35	4744	2641	72	19.9	46	0.5	16.61	3.03	6.13
Coker 319	55	182.01	5018	2750	70	19.7	42	1.0	17.79	2.51	7.67
Coker 347	50	179.07	5478	3053	71	20.1	43	0.5	16.47	2.90	6.29
K 326	57	183.67	5945	3233	69	19.7	39	0.2	17.42	2.43	7.67
K 394	52	180.51	5885	3249	71	20.2	40	0.1	17.97	2.14	9.33
K 399	56	182.14	5234	2869	69	20.3	38	0.2	15.98	2.52	6.74
McNair 373	60	181.75	5151	2831	66	20.6	38	0.5	17.32	2.35	8.19
McNair 944	52	180.38	5230	2885	70	18.4	41	0.3	17.77	2.75	7.46
NC 22NF	52	179.87	4963	2751		18.3	41	0.0	16.72	2.69	6.92
NC 50	53	181.59	5552	3050	71	19.5	42	0.1	17.05	2.37	8.30
NC 82	55	181.96	4982	2732	67	18.7	41	1.1	18.88	2.25	9.82
NC 85	54	180.53	4998	2762	69	19.2	42	0.3	16.98	3.00	6.28
NC 567	55	182.53	5174	2827	69	18.2	45	0.7	18.43	2.71	7.37
NC 628	51	180.38	5124	2830	69	17.8	45	0.1	18.95	2.32	8.77
Speight G-28	51	177.71	5024	2815	68	18.9	38	0.4	17.08	2.24	7.99
Speight G-58	50	177.77	5340	2985	69	18.9	41	0.2	17.85	2.51	7.77
Speight G-70	51	181.31	5414	2982	68	18.7	39	1.0	19.01	2.63	7.67
Speight G-80	50	179.57	5335	2962	68	19.2	39	0.4	17.35	2.32	8.53
VA 182	56	180.71	4917	2710	70	18.7	45	0.7	18.60	2.53	8.72
Mean	53	180.61	5221	2883	69	19.3	42	0.4	17.58	2.60	7.57
BLSD (K-100)	7	4.07	481	260	2	1.6	3	0.7	1.91	0.29	1.71
CV (%)	10	2	8	7	3	7	5	91	10	12	19

CHARACTERIZATION OF FLUE-CURED VARIETIES

W. W. Weeks

Tobacco growers are interested in producing the variety that will give the largest net income. This has led to production of high yielding varieties. Obvious varietal differences can be obtained from cultural management and curing of flue-cured types. Older tobacconists have led the acclaim that current varieties produced by growers are less aromatic, therefore less desirable than older varieties. All of the varieties recently released have passed moderate screening to pass minimum standards for varietal release and breeders have also transferred resistance to devastating diseases into the current varieties.

An experiment was planned and grown at Reidsville in 1984 including popular varieties grown in the 1940, 1950, 1960, 1970 and more currently grown ones. Sixteen varieties were grown altogether. The objective of this effort was to study each variety chemically and to classify discriminately each variety from the chemical data.

MATERIALS AND METHODS

Three replications of each variety were grown. Each plot consisted of 159 plants and larger plots were grown to provide at least 50 lbs. of cured tobacco from each replication for cigarette making.

Samples were taken by primings from each replication and composite samples over primings were also taken. The samples were analyzed chemically for total alkaloids and reducing sugars and ten grams from each composite sample were analyzed by capillary gas chromatography for neutral volatiles. These compounds are volatile organic compounds from flue-cured tobacco that are present in tobacco and tobacco smoke. The contribution of at least some of these compounds to smoke flavor and aroma are known, however the effect of others are unknown. Profiling of neutral volatiles exhibit only a few, a hundred or more, of the 1200 organic constituents found in the tobacco leaf that contribute to smoke character. Neutral volatiles are obtained by steam distillation from small representative samples and each sample is characterized chromatographically by temperature programming of the capillary G.C.. The capillary column consists of a stationary phase that separates compounds from the sample by polarity. Identification of specific compounds from the profile gives specific information about the sample. The contribution of certain compounds from tobacco is known, because of the magnitude of these compounds in tobacco, however nothing is known about constituents that exist in minute concentrations they too make contributions although they are neglected. This fact established, it is also likely that compounds similar in structure and polarity compliment each other taste-wise and in aroma and since aroma and taste are synonymous compounds from the profiles can be separated into groups and the combined quantitation of groups can be compared between samples. Further evaluation of each sample is made by obtaining ratios between groups from each chromatogram. Five groups are taken from each chromatogram dividing each profile into low molecular weight polar compounds that are described as sweet and pleasant (group 1), second group as

ketonic and woody in nature, phenylalanine derivatives that have floral like aroma but in higher concentration are bitter, (group 3) neophytadiene that composes up to 50% of the total volatile oils obtained from steam distillation of a small tobacco sample (group 4) and the largest of the five groups, contains the greatest number of compounds and it is the largest group made up of forty or more oxygenated compounds identified as important constituents in taste and flavor of tea, food and other sources.

Smoke flavor is not evaluated specifically like foods and beverages but a balance in the many constituents found in the smoke is necessary for good smoking quality. This indicates that tobacco with the highest total quantities of individual volatile compounds are not necessarily the choice smoking material but samples with the highest ratios between groups and total volatiles, are actually the choice tobaccos.

VARIETY RANKING

Using the scheme previously described, a composite sample of each replication and variety was run by capillary gas chromatography. Each chromatogram comprised a profile of a variety. The profile was separated into five specific groups by retention times and each group from all varieties consisting of the same number of peaks. The differences between varieties were quantitative rather than qualitative.

Total volatiles from each variety were averaged over replications and each individual group was also averaged giving a total mean and group mean for each variety. Each variety was ranked from highest to lowest by group, individual groups within each variety were combined and the varieties were ranked from highest to lowest. Individual ratios between certain groups and total volatiles and ratios between specific groups were obtained for each variety and the varieties were further ranked from highest to lowest. A total of 13 categories for each variety was established and a total value over all categories was obtained for each variety. The variety with the largest total was ranked first, etc..

Rank of Varieties From Volatile Data

Year Grown	Sum of Categories	Variety
Current(CK)	164	NC 95
Current	155	K 399
Current	149	SP 70
Current	139	NC 82
Current(CK)	129	2326
1940	111	Gold Dollar
1960	107	C - 319
1950	103	Gold Harvest
1940	102	Hicks
1970	97	McNair 944
1940	92	402
1940	85	Dixie Bright 101
1970	82	SP - 28
1970	82	Coker 347
1960	76	C 187 - Hicks
1950	74	Gold Cure

Genetic differences in flue-cured tobacco count for chemical differences. The ranking of varieties from this study clearly indicates quantitative differences. This difference is very prominently demonstrated between profiles from different varieties but no difference was observed within a variety. The rank and order of varieties were made entirely from volatile data obtained from the capillary G.C. profiles.

DIFFERENCE IN VOLATILE COMPOUNDS FROM HIGH AND LOW TAR SAMPLES

Recent emphasis in the reduction of tar and nicotine to produce a safer cigarette has encouraged researchers to seek ways of altering tar in cigarette smoke. Reduction of tar suggests a decrease in many organic constituents from the tobacco. For this reason, an alternate approach would be to reduce the compounds that produce hazardous effects and only retain those components that contribute satisfaction such as nicotine and other flavor components. Researchers have proven that tar and flavor are positively correlated. Reduction in tar, according to this analogy, would reduce flavor.

Several years ago plant breeders at this university engaged in an effort to reduce tar selectively and with a second motive to retain nicotine constant. To date seven generations of plants have been grown and studied.

MATERIALS AND METHODS

Thirty-two flue-cured samples were combined to give eight samples. These samples were taken from high and low tar plant populations from two locations. Four samples from each location were taken from samples previously analyzed for alkaloids and tar and represented the mean of each type from each location. The samples were combined to increase the sample size for volatile profile analyses to determine if there was a quantitative difference in individual volatile compounds from high and low tar samples. Duplicate analyses were made of each sample.

RESULTS

A quantitative comparison was made between 48 compounds from the two groups of samples analyzed by capillary gas chromatography. Thirty-eight of the 48 compounds were higher quantitatively from the high tar samples, there were two compounds in which there was no difference and eight compounds from the low tar samples that were higher but not statistically significant. Fourteen of the 38 compounds that were higher from the high tar samples were statistically significant from the same compounds from the low tar samples. Individual compounds of relatively high magnitude and considered to be important contributors to flavor and transferred almost quantitatively in the smoke such as solonone, damoscenone, neophytadiene, and 5 megastigmatrienone isomers were significantly different and higher in the high tar samples.

This test does not completely verify that breeding and selecting for low tar tobacco changes the flavor of tobacco, but it does indicate that genetical inheritance of chemical constituents in flue-cured tobacco is important and that reduction in tar results in universal changes in the tobacco.

5149 - ANALYTICAL SERVICE OF EXPERIMENTAL FLUE-CURED TOBACCO

W. W. Weeks

The analytical service laboratory has completed the request for analyses on all 1984 flue-cured samples. Analyses for all project leaders requesting data from experiments in 1984 that is used for seed selection, or for planning of 85 experiments have been completed. As in years past the analyses for the 84 crop was predominately alkaloid and reducing sugars. With the exception of 400 samples the 84 crop was all flue-cured tobacco. Thirteen thousand samples have been analyzed. Samples from 1984 exhibited higher than normal reducing sugars and were considerably lower in alkaloids.

PUBLICATIONS

Genetic Modification of Total Particulate Matter: D. F. Matzinger, W. W. Weeks, E. A. Wernsman. 154-51. Recent Advances in Tobacco Science, Volume 10. 1984.

Fourier Analyses Enhances NIR Diffuse Reflectance Spectroscopy: W. F. McClure, Abdul Hamid, F. G. Geisbrecht, and W. W. Weeks. 322-328. Applied Spectroscopy, Volume 28, Number 3, 1984.

PAPERS PRESENTED

Quantitative Changes in Steam Volatiles from Genetically Modified Flue-Cured Tobaccos: W. W. Weeks and D. F. Matzinger. Tobacco Chemist Research Conference.

Tobacco Flavor and Aroma: W. W. Weeks. Korean Tobacco Science Society, Korean Ginseng and Tobacco Research Institute, Yusong, Korea, May 28, 1984.

ANNUAL REPORT ON TOBACCO WEED CONTROL RESEARCH

April 1, 1983-February 29, 1984

Title: Project State NCO-3774, Effective and Efficient Weed Management Programs for Corn, Tobacco, Small Grains and Sorghum
and
Project State NCO-3569, Vegetation Control in No-Tillage Crop Production

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Abstract: Two new experimental herbicides continued to be promising for weed control in conventional and no-till tobacco. These were imazaquin (Scepter) and Command. Preplant, soil incorporated treatments of imazaquin caused unacceptable crop injury. However, post-bedding surface and over-top applications gave good weed control with little crop injury. Postemergence treatments were very promising in that they gave excellent control of ragweed, pigweed and morningglory. Lambsquarters and crabgrass control was less. Soil-incorporated and over-top applications of Command gave good grass and broadleaf weed control. Over-top application at 1.25 lb/A also gave good sicklepod control. Chlorotic spots on the lower leaves of tobacco were noted with Command. Preliminary evaluations showed Cinch herbicide to be promising for use on tobacco. Several postemergence grass herbicides continued to give good to excellent annual grass control without crop injury. Generally cool and wet weather during the early part of the burley tobacco growing season probably accounted for fair control of common ragweed with Enide at 6.0 lb/A and good control of hairy galinsoga with Enide at 4.0 and 6.0 lb/A and Devrinol at 2.0 lb/A. Weed control in no-till tobacco tests was generally poor and yields averaged only 72% as much as conventional tobacco. An extremely wet July probably caused excessive herbicide leaching and interferred with allelopathic weed suppression from the mulch. Increasing fertilizer rates to two times the normal rate increased yields without adversely affecting quality. Although etch virus severely damaged burley tobacco tests, there were no significant differences in yield or quality between the conventional and no-till burley tobacco in a rye mulch.

I. Summary of Research (Tests in Group 1):

1. General Experimental Methods: Nine types of experiments were conducted in the field in 1984. This research will be separated into two major groupings which will be reported in the following order. The first group consists of several different tests involving herbicide evaluations in conventional flue-cured tobacco. The second group consists of several experiments concerned with the production of no-till flue-cured and burley tobacco.

Experiments in Group 1, the herbicide evaluation tests, will be referred to as (A) Herbicide Evaluation Test in Tobacco, (B) Post-emergence Herbicide Evaluation Test in Tobacco, (C) Post Herbicide Evaluation Test in Tobacco, (D) The Evaluation of Scepter in Tobacco, (E) Burley on-Farm Weed Control Tests, and (F) Preliminary Evaluation of Cinch Herbicides for Tobacco.

These tests were conducted at the following research stations: the Central Crops Research Station near Clayton, the Upper Coastal Plain Research Station near Rocky Mount, the Lower Coastal Plains Tobacco Station near Kinston and the Upper Piedmont Research Station near Reidsville. On-farm tests were in the burley area of western North Carolina.

Product description, including chemical names, common names and manufacturers of compounds used in 1984 are given in Table 1. Other detailed information (such as soil description, tobacco varieties, and treatment dates) is included in the narrative with each test. These narrative data tables are in the Appendix, along with weather data (Appendix Tables 1-16).

Herbicide treatments were applied broadcast with a CO_2 pressurized backpack sprayer having five whirl-chamber nozzles on a boom at 20-inch spacings. The sprayer was operated at 3 mph and 20 psi to deliver 20.1 gal/A. For incorporated treatments, herbicides were disked in immediately after application with a tandem disc harrow set to cut 4 to 6 inches deep and operated at 4 mph. Two lengthwise trips were made down and back in each plot with the disc. In the surface-applied treatments, all beds were first knocked off to obtain an 8 to 10-inch flat bed top and herbicides were applied broadcast before transplanting. A one-row power-driven rotary cultivator was used to incorporate treatments on top of the beds. The overtop treatments were applied to the plots immediately after transplanting. Post treatments were applied overtop to the plants three to four weeks after transplanting. After the layby cultivation, herbicides were applied using a two-nozzle boom at 18.3 GPA for a semi-directed spray. Any variations in these methods will be given in specific methods for each test.

The tobacco was grown according to standard practices and was harvested and cured by flue-cured or burley methods. All tobacco on the research stations was irrigated as needed except at the Kinston location. An official grader rated the tobacco by plot and by priming. The average price per grade from September of 1983 to September of 1984 was used in calculating the value per acre for the treatments. Some of the tests were analyzed for certain chemical constituents in the Crop Science Department tobacco chemistry laboratory.

All in-field ratings of experiment plots were made independently each time by two persons and these values were averaged to obtain a rating for a particular plot. Weed control ratings are based on a 0 to 100 scale; 0 = no control and 100 = perfect control. Injury

ratings are based mainly on stunting of tobacco plants unless otherwise specified (0 = no injury, 100 = crop kill).

Rainfall data for the tobacco research locations are given in Appendix Tables 1 through 16.

A. Herbicide Evaluation Test in Tobacco -- The herbicides are listed in Tables 2 and 3. A randomized complete block design was used at two locations, Kinston and Rocky Mount, with 4 replications each. Both tests received two cultivations during the growing season.

Weed control and injury ratings were taken throughout the growing season. Weed control at Kinston was based on common lambsquarters at <1/sq. ft. and sicklepod <1/sq. ft. At the Rocky Mount location, weed ratings were based on large crabgrass at 1-5/sq. ft. and carpetweed <1/sq. ft. Injury ratings were on percent stunting (0 = no injury and 100 = complete kill). Also, light interveinal bleaching on the lower leaves was noted in certain treatments with the number of plants in which it occurred.

Results: At the Kinston location, Command at .75, 1.0, and 1.25 lb ai/A applied PBI and OT gave excellent control of common lambsquarters. The surface application gave fair to excellent common lambsquarters control. The only treatment that gave good control of sicklepod was Command at 1.25 lb ai/A applied OT. All other treatments gave poor to fair control of sicklepod. Chlorotic spots on lower leaves were noted on all Command plots except .75 lb ai/A treatment applied OT. However, there was no reduction in yield, quality, or chemical constituents. Scepter at .06 and .13 lb ai/A gave excellent common lambsquarters control but severely injured the tobacco. Both Enide at 6.0 lb ai/A and Paarlan at 1.5 lb ai/A (STANDARDS) gave good common lambsquarters control.

At the Rocky Mount location, all treatments gave very good to excellent large crabgrass and carpetweed control through midseason. Again Command caused light chlorotic spotting, but there were no significant differences in yield, quality, or chemical constituents. Scepter at .06 and .13 lb ai/A applied PBI gave moderate stunting in early and midseason. However, at this location, the tobacco recovered by harvest and there were no significant differences in yield, quality, or chemical constituents.

B. Postemergence Grass Herbicide Test -- The herbicides used are listed in Tables 4 and 5. A randomized complete block design with 4 replications each was used at both the Rocky Mount and Reidsville locations. The plots were 25 feet in length and contained three 45-inch rows. Plant density was later cut back to approximately 12 plants per row. Tobacco was transplanted and left without cultivation for approximately two to four weeks. When the grass was 2 to 4 inches in height, all treatments were applied broadcast directly over the top of the tobacco.

After the layby cultivation, treatments consisted of a broadcast application applied using a two-nozzle boom directed to the row middles and base of the plants with the chemical coming in contact with the lower leaves.

Weed control and injury ratings were taken throughout the growing season. Weed control ratings at Rocky Mount were based on large crabgrass at 1-5/sq. ft. At Reidsville, weed control ratings were based on large crabgrass at 1-3/sq. ft. Injury ratings were based on percent stunting (0 - no injury and 100 = complete kill).

Results: At Rocky Mount, all treatments gave excellent early and midseason crabgrass control except SC 1084 at .16 and .50 lb ai/A, which performed poorly. Treatments 5 and 6 were miscalculated by the computer program and 4X the recommended use rates were applied. Some early and midseason injury was observed but it did not affect yield, quality, or chemical constituents. Yields from treatment 10 were discarded because of problems during the curing or handling process. Yields, quality, and chemical constituents were not significantly different among treatments.

At the Reidsville location, overtop treatments were applied 10 days after transplanting and grass was emerging to the 1-leaf stage. Control was excellent with PP005 and with Fusilade applied OT. All post overtop treatments gave fair to excellent control of large crabgrass depending on coverage. At the POT application date, tobacco size varied; therefore, coverage under and around the plants varied. Treatments 5 and 6 were miscalculated and 4X the recommended use rates were applied. Some early and midseason injury was observed with the higher rate. There were no significant differences in yield, quality, and chemical constituents among the treatments.

C. Poast Herbicide Screening Test in Tobacco -- Herbicides used are listed in Tables 6 and 7. A 4-replication, randomized complete block design was used at two locations, Kinston and Rocky Mount. Plot size was three 45-inch rows by 20 feet. Plant density was later cut back to 10 plants per row. Tobacco was transplanted and left without cultivation for approximately four weeks. When grass was 2 to 4 inches in height, all POT treatments were applied, broadcast directly overtop the tobacco.

After the layby cultivation, treatments consisted of broadcast application applied using a two-nozzle boom semi-directed to the row middles and base of the plants with some chemical coming in contact with the lower leaves.

Weed control and injury ratings were taken throughout the growing season. At Kinston, no weeds emerged and only injury ratings were made. At Rocky Mount, weed ratings were based on large crabgrass at 1-5/sq. ft.

D

E.

Results: At Kinston, there was no injury of any kind observed during the growing season and there were no significant differences in yield, quality, grade index, or chemical constituents.

At the Rocky Mount location, all rates of Poast applied POT gave excellent control of large crabgrass in early and midseason. All layby applications with cultivation also gave excellent midseason control of large crabgrass. After late season emergence of large crabgrass, control was less. No injury was observed from any treatments throughout the growing season. Yield, quality, grade index, and chemical constituents were not significantly different among treatments.

D. The Evaluation of Scepter (Imazaquin) in Tobacco -- Herbicides used are listed in Tables 8, 9 and 10. Imazaquin was tested during the 1983 and 1984 growing seasons. Application rates of imazaquin evaluated were 0.25 lb/A and 0.38 lb/A. Methods of application investigated included: prebed incorporated, over-the-top immediately after transplanting, post-bed incorporated, post-bed surface (1984), early post and post-directed at layby (1984).

Results: Imazaquin provided excellent control of common lambsquarters (*Chenopodium album*), common ragweed (*Ambrosia artemisiifolia*), redroot pigweed (*Amaranthus retroflexus*), and ivyleaf morningglory (*Ipomoea hederacea*), with all soil-applied methods of application. Acceptable control of large crabgrass (*Digitaria sanguinalis*) was also obtained with the soil-applied methods. Post applications of imazaquin provided excellent control of common ragweed, redroot pigweed and ivyleaf morningglory. Imazaquin was less effective postemergence on lambsquarters and large crabgrass (Table 8).

Yield and percent vigor reduction data show that at rates tested, preplant incorporated treatments of imazaquin caused unacceptable tobacco injury. However, all other methods of application evaluated provided acceptable safety to tobacco (Tables 9 and 10).

These data have provided a good base for additional research with imazaquin as a broadleaf herbicide in flue-cured tobacco. Future field testing will include lower rates of imazaquin used in combination with a grass herbicide such as pendimethalin.

E. Burley On-Farm Weed Control Tests -- Cooperating with R. L. Davis, Burley Extension Specialist, 13 on-farm tests were put out in 10 counties in the burley-producing area in western North Carolina. Herbicides used are shown in Table 11. Rates used were: Prowl (1.0 lb ai/A PBI), Devrinol (2.0 lb ai/A OT), Enide (4.0 and 6.0 lb ai/A OT), and Paarlan (1.5 lb ai/A PBI). Plot size was 16 feet (4 rows) by 40 feet with three replications. Weed control ratings were taken about 21 days after transplanting and before the first cultivation. Herbicides were applied as recommended.

Results: Common ragweed control was poor (45-58%) except with Enide at 6.0 lb ai/A OT, which gave fair control (71%). Control of

quackgrass was poor except with Paarlan at 1.5 lb ai/A which gave fair control (70%). Also, Paarlan gave good control of seedling johnsongrass (83%). Control of both quackgrass and johnsongrass was higher than expected with Paarlan. Control of smartweed from all treatments ranged fair to good except Prowl at 1.0 lb ai/A which was poor. All treatments gave good large crabgrass control (90-94%). Common purslane control was poor with Paarlan at 1.5 lb ai/A. All other treatments gave fair to good control (76-85%). This season good control of hairy galinsoga was achieved with Enide at both rates and Devrinol at 2.0 lb ai/A. Both incorporated treatments, Prowl and Paarlan, gave better control of common lambsquarters and redroot pigweed (83-86%) than the OT treatments. Cocklebur control was very poor with all treatments except Prowl where the high control (88%) was unexplainable but was from one location only. None of the treatments controlled morningglory. Fall panicum control was fair to good with all treatments. Early season injury, stunting, was not significant except with Prowl at 1.0 lb ai/A. But, only at three locations of 12 was any injury observed. The weather during early season tobacco growth was generally cool and wet.

F. Preliminary Evaluation of Cinch Herbicide for Tobacco -- Herbicides used are listed in Table 12. A randomized complete block design with three replications was used at two locations, Rocky Mount and Reidsville. Plot size was three rows (2 treated, 1 untreated border) x 20 feet. The herbicide was applied overtop immediately after transplanting. Weed control ratings and crop injury ratings were taken June 15, July 15 and August 15 for the Rocky Mount location. Weeds present and density for the ratings were: large crabgrass, 3-5/sq. ft. for all dates and carpetweed, 1-3/sq. ft. for the first date and <1/sq. ft. for the other dates at the Rocky Mount location. At Reidsville ratings were taken June 19, July 1 and September 10. For all ratings, large crabgrass was 1/sq. ft. and redroot pigweed <1/sq. ft. Plots were cultivated two times. All injury ratings were based on stunting of the tobacco plants.

Results: Large crabgrass and carpetweed control was excellent (93-100%) for the whole season, with no crop injury at the Rocky Mount location. At the Reidsville location, large crabgrass control was excellent (95-100%) for the first two rating dates for both rates. In September, the 0.75 lb/A rate was giving 88% control and the 1.0 lb/A rate 97%. Redroot pigweed control was good to excellent (85-100%) for all dates and both rates. Pigweed density, however, was sparse. There was slight injury (5%) in June and September, but was probably not biologically significant. Yields were not taken.

Summary of Research (Tests in Group 2):

1. General Experimental Methods: The second group of experiments were designed to evaluate the feasibility of growing no-till tobacco, to study fertilization differences in no-till vs. conventional tobacco, and to study weed control. Land was prepared, soil treatments (soil insecticide/nematicide or multi-purpose fumigant, depending on

location) were applied, and land was bedded in the fall for no-till tobacco. A rye cover crop was sown and seeds were covered with a rolling cultivator and adjusted to fit the beds. Approximately two weeks before transplanting, grain was killed with paraquat and in some cases a half rate of residual herbicide was mixed with the paraquat. Tobacco was transplanted using a modified commercially available no-till one-row transplanter. The transplanter was equipped with a double-disk opener and wide, rubber-tired wheels on an articulating frame. A coulter in front of the opener was used where mulch was heavy. Tobacco was fertilized by side-dressing with 40 N - 40 P_2O_5 - 120 (K_2O) at planting and addition of 25 units of N was sidedressed later in the season. Variations in some tests are noted.

All background information is included in the narrative reports for each test. Any variations in methods are given in the specific descriptions of each test.

The tests will be referred to as (G) No-Till Tobacco Herbicide Evaluation Test, (H) Fertilization Test in No-Till and Conventional Tobacco, and (I) No-Till vs. Conventional Burley Tobacco Test. These tests were conducted at the following research stations: the Central Crops Research Station near Clayton, the Upper Piedmont Research Station near Reidsville, and the Mountain Research Station near Waynesville.

G. No-Till Tobacco Herbicide Screening Test -- Herbicides used are listed in Tables 13 and 14. The objective of this test was to evaluate new herbicides and methods of application for improved weed control in a no-till situation. A randomized complete block design was used at two locations, Clayton and Reidsville, with 4 and 3 replications, respectively. The application methods used were as follows: both paraquat and residual herbicide applied at grain kill, paraquat applied for grain kill and a residual herbicide applied over-the-top after transplanting, and paraquat applied for grain kill and postemergence herbicides applied after the weeds had emerged.

Results: At the Clayton location, all treatments of Scepter applied at grain kill and the higher rate of .38 lb ai/A applied over-the-top gave excellent early season common ragweed control. Treatments of Scepter applied at grain kill and the higher rate of .38 lb/A applied OT gave good large crabgrass control. All treatments of Scepter injured the tobacco in early season by causing a malformation of the new leaves (puckering). By midseason this injury was no longer observable. All rates and methods of application of Command gave very good to excellent control of common ragweed and large crabgrass with no crop injury. With treatments of Scepter and Fusilade applied in sequential applications-POT, control of large crabgrass was poor. There apparently is an antagonistic effect with combinations of these herbicides even if applied sequentially. Results by other researchers at this university are similar.[1]

[1]Personal communication with Dr. Harold Coble, Crop Science Department.

After midseason, remaining weeds were removed by hand in order to salvage yields. The only significant difference in yield and quality were due to weed competition. There were no significant differences in grade index or chemical constituents.

At the Reidsville location, all treatments with Command and Scepter (except the Paraquat plus Scepter at grain kill), gave very good to excellent early season control of common ragweed and Pennsylvania smartweed. Both Paraquat plus Scepter at grain kill and Paraquat with the standard Enide gave poor control. No-till tobacco growth was poor at this location due mainly to poor weed control. Only green plant weights were taken for yields. All treatments that gave fair to good early season control outyielded the poor treatments even though they were not significantly different. There was an unusually high amount of rainfall during July.

H. <u>Fertilization Test in No-Till and Conventional Tobacco</u> -- Yield, quality, grade index, and chemical constituents are listed in Table 15. The objective of this experiment was to determine if higher fertilization rates would increase no-till tobacco yields without adversely affecting quality. The two methods of application used were a band surface and a broadcast surface. Base fertilization rates after transplanting included standard (40 lb N), one-half increase in standard (60 lb N) and 2X increase in standard (80 lb N). All treatments received 25 lb N sidedressed two to three weeks after transplanting.

<u>Results</u>: At the Clayton location, both the standard and the broadcast 2X rate in the no-till gave significantly higher yields than all the other fertilizer treatments. Weed control was poor in all the no-till plots and, therefore, influenced tobacco growth. All conventional tobacco significantly outyielded the no-till tobacco. However, weed control was good in the conventional plots. Sugars and TA data were not available at this report date.

At the Reidsville location, land shortage reduced test size by two treatments. The broadcast one-half rate increase treatments in both no-till and conventional were omitted from the test. The herbicide treatments did not effectively control common ragweed or Pennsylvania smartweed in the no-till plots. These weeds competed with the tobacco and reduced yields significantly as compared to the conventional tobacco. The best yielding no-till treatments were standard, standard 2X, and broadcast 2X rate. There were no significant differences in grade index and percent sugar. Total alkaloids were unexplainably lower in treatments 3 and 4.

I. <u>Burley Tobacco No-Till vs. Conventional Herbicide Test</u> -- Herbicides and yields are listed in Table 16. The test was designed to determine the performance of two new experimental herbicides against a standard for increased broadleaf control and to determine yields of no-till vs. conventional burley tobacco. A split block design was used with 4 replications. Plot size was two treated rows, 48 inches x 30 feet. After one early rating, plots were spot treated with

Scepter and Fusilade to keep the test weed-free throughout the growing season.

Results: Weed control was excellent in early season with all treatments. About one month after transplanting, etch virus appeared in the no-till and conventional plots, with the no-till burley showing more incidence of the disease. The no-till plots were smaller and therefore more susceptible at the time of attack. It is possible that the virus-carrying aphids were attracted more to the smaller, more yellow tobacco with dead mulch showing than the larger, greener conventionally tilled tobacco. Because of the virus, yields were taken randomly from 16 plots in the no-till and conventional tobacco which were least affected by the etch virus. There were no significant differences in yield or quality.

II. Graduate Students:

A. R. F. Walls (Co-Chairman), "The Potential of Imazaquin for Weed Control in Tobacco"

B. Deidre DeBruhl, R. J. Reynolds Undergraduate Research Apprentice, "Weed Management Practices in Conventional and No-Till Tobacco."

III. Postdoctoral Fellows: None

IV. Publications:

Shilling, D.G., R.A. Liebl, and A.D. Worsham. 1985. Rye and wheat mulch: The suppression of certain broadleaved weeds and the isolation and identification of phytotoxins, pp. 243-271, in A. C. Thompson (ed.), ACS Symp. Ser. No. 268, The Chemistry of Allelopathy. American Chemical Society, Washington, D.C.

Worsham, A.D. 1985. No-till tobacco and peanuts, in A. F. Wiese (ed.), Weed Control in Limited Tillage Systems. Weed Sci. Soc. Amer. Monogr. Ser. No. 2, Champaign, Ill. (in press).

Worsham, A.D. 1984. Crop residues kill weeds: Allelopathy at work with wheat and rye. Crops and Soils Magazine, Nov., pp. 18-20.

Shilling, D.G. and A.D. Worsham. 1984. The effect of rye (Secale cereale L.) mulch, tillage and crop competition on weed densities in three no-till systems. Weed Sci. Soc. Amer. Ann. Meeting, Abstract No. 145, p. 56.

Shilling, D.G., R.A. Liebl, and A.D. Worsham. 1984. Suppression of broadleaf weeds by rye and wheat straw and isolation and identification of phytotoxic compounds. Proc. 7th Ann. Southeast No-Tillage Systems Conf., Headland, Alabama, Abstract, pp. 131-132.

Doyle, Sandra L. and A.D. Worsham. 1984. Reducing soil erosion in tobacco through no-tillage. Proc. 7th Ann. Southeast No-Tillage Systems Conf., Headland, Alabama, Abstract, pp. 142-144.

Worsham, A.D., D.G. Shilling, and R.A. Liebl. 1984. The suppression of certain broadleaved weed species by rye (Secale cereale L.) and wheat (Triticum aestivum L.) mulch and isolation and identification of phytotoxins. The 1984 Int. Chem. Congress of Pacific Basin Societies, Agrochemistry Division, Abstr. No. 02 F 15.

Walls, R.F., Jr., W.K. Collins, A.D. Worsham, F.T. Corbin, and J.R. Bradley. 1985. Research results with imazaquin on flue-cured tobacco in North Carolina. South. Weed Sci. Soc. 38:(in press).

V. Manuscripts Accepted for Publication: None

VI. Manuscripts in Review:

Shilling, D.G., A.D. Worsham, and D.A. Danehower. The effects of mulch, tillage and herbicides on weed control, yield and quality in flue-cured tobacco (Nicotiana tabacum L.). Weed Science.

Shilling, D.G., A.D. Worsham, L.A. Jones, R.F. Wilson, and C. Parker. The suppression of certain weed species by rye (Secale cereale L.) mulch and isolation, characterization and identification of water-soluble phytotoxins from rye. Jour. Agri. and Food Chem.

Whatley, L. and A.D. Worsham. Ragweed interference in flue-cured tobacco. Weed Science.

Wood, Sandra D. and A.D. Worsham. Reduction of soil erosion through no-tillage transplanting of tobacco. Jour. Soil and Water Cons.

VII. Papers Presented at Professional Meetings:

Shilling, D.G. and A.D. Worsham. The effect of rye (Secale cereale L.) mulch, tillage, and crop competition on weed densities in three no-till systems. Weed Sci. Soc. of Amer. Ann. Meeting, February 1984.

Worsham, A.D. Weed management in burley tobacco. Ext. Training Workshop in Burley Tobacco. February 1984.

Liebl, R.A., D.G. Shilling, and A.D. Worsham. Suppression of broadleaf weeds by mulch in four no-till cropping systems. Amer. Chem. Soc., Div. of Pesticide Chem., Symp. on the Chemistry of Allelopathy, 187th ACS National Meeting. April 1984.

Shilling, D.G., R.A. Liebl, and A.D. Worsham. Isolation and identification of compounds from rye (Secale cereale L.) and wheat (Triticum aestivum L.) straw phytotoxic to certain weed species. Amer. Chem. Soc., Div. of Pesticide Chem., Symp. on the Chemistry of Allelopathy, 187th ACS National Meeting, April 1984.

VIII

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Worsham, A.D., D.G. Shilling, and R.A. Liebl. The suppression of certain broadleaf weed species by rye (Secale cereale L.) and wheat (Triticum aestivum L.) mulch and isolation and identification of phytotoxins. The 1984 Int. Chem. Congress of Pacific Basin Societies, Symposium on Allelopathy, Agri. Chem. Div., December 1984.

Worsham, A.D. Progress in weed control in no-till transplanted tobacco. The 31st Tobacco Workers Conf., January 1985.

Walls, F.R., Jr., J.B. O'Neil, W.K. Collins, A.D. Worsham, Fred Corbin and J.R. Bradley. Results of Scepter herbicide for broadleaf weed control in flue-cured tobacco in North Carolina. The 31st Tobacco Workers Conference, January 1985.

Walls, F.R., Jr., W.K. Collins, A.D. Worsham, F.T. Corbin, and J.R. Bradley. Research results with Scepter herbicide on flue-cured tobacco in North Carolina. Annual Meeting South. Weed Sci. Soc., January 1985.

VIII. Graduate Student Theses Completed During the Reporting Period: None

IX. Acknowledgments:

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APPENDIX

Table 1. HERBICIDES USED IN 1984

Company	Common Name or Designation	Trade Name or Other Designation	Formulation	Chemical
American Cyanamid	Imazaquin	Scepter	1.5 lb/gal E	2-(4-isopropyl-4-methyl-5-oxo-2-immidazolin-2-yl)-3-quinolinecarboxylic acid
American Cyanamid	Pendimethalin	Prowl EC	4 lb/gal E	N-1-ethylpropyl)-3,4-dimethyl-2, 6-dinitrobenzenamine.
BASF	Sethoxydim	Poast	1.53 lb/gal EC	2-{1(ethoxyamino)-butyl 1}-5-{2-(ethylthio)-propyl}-3-hydroxy-2-cyclohexene-1-one
Chevron		X77	NA	Surfactant
Chevron	E-36290	Selectone	4 lb/gal EC	
Chevron	Paraquat	Paraquat CL	2 lb/gal	1, 1-dimethyl-4,4-bipyridinium ion.
Dow	Haloxyfop	Verdict	2 lbs/gal	Methyl 2-(4-((3-chloro-5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy)propanoate
DuPont	BPX-6202	Assure	0.8 lbs/gal	2-(4-((6-Chloro-2quinoxalinyl) oxy)-phenoxyl)-propionic acid, ethyl ester
Elanco	Isopropalin	Paarlan	6.0 lbs/gal EC	2,6-Dinitro-N-N-dipropylcumidine
FMC	FMC57020	Command	4 lb/gal EC	2-(2-Chlorophenyl)methyl-4, 4-dimethyl-3-isoxazolidinone
Helena		Agridex	NA	Crop-oil concentrate
ICI	PP005		1 lb/gal E	(+)-butyl 2-{4-((5-(trifluoromethyl)-2-pyridinyl)oxy)phenoxy}propanoate
ICI	Fluazifopbutyl	Fusilade	4 lb/gal E	butyl 2-{4-(5(trifluoromethyl-2-pyridyloxy))phenoxy}propanoate
Stauffer	Napropamide	Devrinol	50W	2-(a-napththoxy)-N,N-diethylpropionamide
Shell	Cinmethylin	Cinch	7 lb/gal EC	{exh-1-methyl-4-(methylethyl)-2-[(2-methylphenyl) methoxy]-7-oxabicyclo] 2.2.1] heptane}
Stauffer	SC-1084		50W	
Upjohn	Diphenimid	Enide	90W	N,N-dimethyl-2,2-diphenylacetamide

TABLE 2. TOBACCO HERBICIDE EVALUATION TEST, KINSTON, N. C. 1984

Tr. No.	Herbicide	LB/A	Method[1]	% Weed Control[2] LQ1 May 14	LQ2 June 12	LQ3 Aug. 9	S1 May 14	% Injury INJ1 May 14	INJ2 June 12	INJ3 Aug. 9	Yield and Quality #/A	$/A	$/CWT	Grade Index Value	Chemical Constituents Sugar (%)	TA (%)
1	COMMAND	0.75	PBI	93	95	96	63	0	0	0	2586	4373	169	46	10.3	2.53
2	COMMAND	1.00	PBI	95	96	99	55	6*	4*	0	2600	4429	171	46	4.4	1.77
3	COMMAND	1.25	PBI	94	94	96	63	1*	0	0	2915	4991	171	47	7.7	2.09
4	COMMAND	0.75	SUR	78	86	92	70	4*	0	0	2544	4348	171	44	8.3	2.38
5	COMMAND	1.00	SUR	89	93	96	69	6*	3*	0	2716	4636	171	45	6.3	1.90
6	COMMAND	1.25	SUR	98	99	99	60	3*	3*	0	2403	4143	172	47	11.4	2.45
7	COMMAND	0.75	OT	100	100	100	63	5*	1*	0	2603	4487	172	45	10.8	2.57
8	COMMAND	1.00	OT	100	100	100	78	13*	0	0	2745	4729	172	43	9.1	2.51
9	COMMAND	1.25	OT	100	98	100	90	3*	0	0	2472	4254	172	44	6.7	1.99
10	ENIDE COMMAND	4.00 0.50	OT LBY	87	90	96	53	3*	0	0	2418	4100	171	46	8.3	2.37
11	ENIDE COMMAND	4.00 1.00	OT LBY	90	90	95	78	9*	5*	0	2777	4791	169	46	9.6	2.46
12	SCEPTER	0.06	PBI	100	100	100	68	70	75	75	1250	2147	172	47	4.9	2.08
13	SCEPTER	0.13	PBI	100	100	100	85	73	84	84	1920	3273	171	46	8.15	2.36
14	PAARLAN	1.50	PBI	94	94	96	70	11	4	0	2568	4423	168	46	6.98	2.06
15	ENIDE	6.00	OT	95	94	98	75	3	1	0	2762	4779	173	46	11.8	2.66
16	CHECK CULT	0.00		30	38	64	40	3	1	0	2495	4270	171	46	7.3	2.36
			LSD.0s	18	14	5	46	14	6	5	576	1009	NS	NS	NS	NS
			CV(%)	14	11	4	31	82	44	37	16	16	2	7	38	23

[1]PBI=Prebed incorporated
SUR=Post bed surface before transplanting
OT =Over top immediately after transplanting
LBY=Postemergence semi-directed after last cultivation

*Average number of plants with clorotic spots on lower leaves. Other injury values based on stunting..

[2]LQ1=Common lambsquarters 1-3/sq. ft.
LQ2=Common lambsquarters <1/sq. ft.
LQ3=Common lambsquarters <1/sq. ft.
S1 =Sicklepod <1/sq. ft.

Table 3. Tobacco Herbicide Evaluation Test, Rocky Mount, N. C. 1984

TRT		Rate	Appli.	% Weed Control[2]						% Injury		Yield & Quality			Grade	Chem. Constituents	
No.	Herbicide	LB/A	Method[1]	CG1 May 31	CG2 July 15	CG3 Aug 15	CW1 May 31	CW2 July 15	CW3 Aug 15	INJ1 May 31	INJ2 July 15	#/A	$/A	CWT	Index Value	Sugars (%)	TA (%)
1	COMMAND	0.75	PBI	100	100	89	95	100	89	1*	0	3873	6966	180	47	27.6	1.74
2	COMMAND	1.00	PBI	92	99	61	95	100	61	0	0	3637	6508	179	47	27.1	1.60
3	COMMAND	1.25	PBI	100	100	68	100	100	68	4*	0	3566	6415	180	46	27.6	1.64
4	COMMAND	0.75	SUR	98	98	75	100	99	75	0	0	3906	7087	181	48	27.6	1.69
5	COMMAND	1.00	SUR	91	98	81	95	99	81	4*	0	3681	6669	181	48	27.1	1.69
6	COMMAND	1.25	SUR	96	99	72	98	99	72	3*	0	3705	6669	180	47	26.0	1.66
7	COMMAND	0.75	OT	100	98	85	100	100	85	0	0	3500	6279	180	48	26.7	1.40
8	COMMAND	1.00	OT	97	100	78	100	100	78	0	0	3683	6615	180	46	25.5	1.68
9	COMMAND	1.25	OT	99	100	82	100	100	82	4*	0	3687	6666	181	46	24.1	1.39
10	ENIDE COMMAND	4.00 0.50	OT LBY	98	99	74	99	100	74	0	0	3890	6990	180	46	25.7	1.56
11	ENIDE COMMAND	4.00 1.00	OT LBY	93	99	78	98	99	78	1	0	3669	6560	179	48	26.9	1.58
12	SCEPTER	0.06	PBI	96	98	64	100	100	64	8	12	3641	6486	178	47	26.7	1.38
13	SCEPTER	0.13	PBI	81	98	76	98	100	76	25	14	3620	6571	182	48	27.6	1.68
14	PAARLAN	1.50	PBI	85	98	77	99	97	77	4	0	3894	7054	181	48	28.5	1.69
15	ENIDE	6.00	OT	98	95	75	100	100	75	4	0	3475	6266	180	48	26.5	1.55
16	CHECK CULT	.	.	0	35	42	0	38	42	1	0	3329	6029	181	47	26.1	1.69
			LSD.05.	12	5	NS	5	5	NS	NS	2.2	NS	NS	NS	NS	NS	NS
			CV%	10	4	31	4	4	40	365	128	10	10	1	4	9	16

*Average number of plants with clorotic spots on lower leaves (all other injury based on stunting).

[1] PBI=Prebed incorporated
SUR=Post bed surface before transplanting
LBY=Postemergence semi-directed after last cultivation

[2] CG1=Large crabgrass 1-3/sq. ft.
CG2=Large crabgrass 1-3/sq. ft.
CG3=Large crabgrass 3-5 sq. ft.
CW1=Carpet weed <1/sq. ft.
CW2=Carpet Weed <1/sq. ft.
CW3=Carpet Weed <1/sq. ft.

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Table 4. Postemergence Grass Herbicide Evaluation Test in Tobacco, Rocky Mount, North Carolina, 1984

TRT No.	HERBICIDE	RATE LB/A	APPLI. METHOD [2]	% Weed Control[2] CG1 May 31	CG2 July 15	CG3 Aug. 15	% Injury INJ1 May 15	INJ2 July 15	INJ3 Aug. 15	Yield and Quality Lbs/A	$/A	$/CWT	GRADE INDEX Value	CHEMICAL CONSTIUENTS SU (%)	TA (%)
1	VERDICT AGRIDEX	0.06 1 qt.	POT POT	100	100	73	1	0	0	3703	6661	180	49	26.5	1.67
2	VERDICT AGRIDEX	0.10 1 qt.	POT POT	100	100	82	0	0	0	3767	6704	178	48	25.6	1.71
3	SC 1084 AGRIDEX	0.16 1 qt.	POT POT	56	76	68	0	0	0	3825	6854	179	47	26.7	1.78
4	SC 1084 AGRIDEX	0.50 1 qt.	POT POT	66	79	89	0	0	0	3911	6989	179	46	26.2	1.64
5	ASSURE AGRIDEX	2.00 1 qt.	POT POT	100	100	90	1*	1*	0	3628	6477	178	47	26.6	1.63
6	ASSURE AGRIDEX	4.00 1 qt.	POT POT	100	100	84	10*	6*	0	3510	6292	179	47	26.0	1.76
7	SELECTONE AGRIDEX	0.15 1 qt.	POT POT	100	100	81	0	0	0	3639	6530	179	47	26.6	1.69
8	SELECTONE AGRIDEX	0.20 1 qt.	POT POT	100	100	86	0	0	0	3624	6477	179	48	25.9	1.85
9	SELECTONE AGRIDEX	0.30 1 qt.	POT POT	100	100	78	0	0	0	4255	7612	179	49	26.9	1.69
10	POAST AGRIDEX	0.40 1.qt.	POT POT	100	100	83	0	0	0	3163**	5684**	180	50	25.7	1.64
11	PP 005 AGRIDEX	0.19 1 qt.	POT POT	100	100	85	0	0	0	3508	5469	177	49	26.7	1.46
12	PP005 AGRIDEX	0.19 1 qt.	OT LBY	99	100	90	0	0	0	3613	6468	179	46	26.5	1.94
13	PP 005 AGRIDEX	0.25 1 qt.	OT OT	100	100	83	0	0	0	3506	6222	177	47	27.3	1.57
14	PP 005 AGRIDEX PP 005 AGRIDEX	0.25 1 qt. 0.25 1. qt.	OT OT LBY LBY	100	100	86	0	0	0	3750	6730	179	47	25.9	1.62
15	FUSLIADE AGRIDEX FUSLIADE AGRIDEX	0.50 1. qt. 0.50 1. qt.	OT OT LBY LBY	100	100	86	0	0	0	3683	6690	180	49	27.8	1.79
16	CHECK CULT			5	41	38	0	0	0	3828	6822	178	46	25.7	1.60
			LSD.05	9	5	20	1	1	–	NS	NS	NS	NS	NS	NS
			CV (%)	8	4	16	149	108	–	12	12	1	5	5	6

[2] CG1 = Large crabgrass 1-3/sq. ft.
CG2 = Large crabgrass 1-3/sq. ft.
CG3 = Large crabgrass 3-5/sq. ft.

[1] POT = Overtop postemergence when weeds are in the 1-2 leaf stage
OT = Overtop immediately after transplanting but some grass had emerged.
LBY = Postemergence semi-directed after last cultivation.

* Rate applied was 4 X that intended because of computer error.

** Yield significantly lower than most other treatments due to one replication being very low in yield due to unknown reasons not related to herbicide treatment.

Table 5. Postemergence Grass Herbicide Evaluation Test in Tobacco, Reidsville, N. C. 1984.

** Yield significantly lower than most other treatments due to one replication being very low in yield due to [illegible]
not related to herbicide treatment.

Table 5. Postemergence Grass Herbicide Evaluation Test in Tobacco, Reidsville, N. C. 1984.

TRT No.	HERBICIDE	RATE LB/A	APPLI. METHOD[1]	% Weed Control[2] CG1 June 26	CG2 July 24	CG3 Aug. 27	% Injury INJ1 June 26	INJ2 July 24	INJ3 Aug. 27	Yield and Quality lbs/A	$/A	$/CWT	GRADE INDEX VALUE	Chemical Constituents SU (%)	TA (%)
1	VERDICT AGRIDEX	0.06 1 qt.	POT POT	90	94	88	0	0	0	3244	5689	175	49	22.5	1.66
2	VERDICT AGRIDEX	0.10 1 qt.	POT POT	76	83	88	0	0	0	3053	5275	173	47	22.7	1.58
3	SC 1084 AGRIDEX	0.16 1 qt.	POT POT	73	91	80	0	0	0	3145	5453	172	45	22.2	1.55
4	SC 1084 AGRIDEX	0.50 1 qt.	POT POT	93	79	90	0	0	0	2913	5138	177	51	19.2	1.57
5	ASSURE AGRIDEX	2.00 1 qt.	POT POT	99	99	84	0*	0*	0	3268	5690	174	48	23.3	1.72
6	ASSURE AGRIDEX	4.00 1 qt.	POT POT	99	78	99	12*	5*	0	3181	5610	177	48	24.0	1.69
7	SELECTONE AGRIDEX	0.15 1 qt.	POT POT	73	80	81	0	0	0	3148	5612	178	53	22.7	1.88
8	SELECTONE AGRIDEX	0.20 1 qt.	POT POT	87	98	85	0	0	0	3280	5873	179	54	20.2	1.74
9	SELECTONE AGRIDEX	0.30 1 qt.	POT POT	94	89	98	0	0	0	3258	5741	176	49	16.4	1.45
10	POAST AGRIDEX	0.40 1 qt.	POT POT	84	100	94	0	0	0	3321	5738	176	49	24.3	1.90
11	PP 005 AGRIDEX	0.19 1 qt.	POT POT	93	99	99	0	0	0	3145	5504	175	48	21.6	1.65
12	PP 005 AGRIDEX PP 005 AGRIDEX	0.19 1 qt. 0.19 1 qt.	OT OT LBY LBY	99	100	100	0	0	0	3093	5421	174	47	19.6	1.49
13	PP 005 AGRIDEX	0.25 1 qt.	OT OT	100	100	100	0	0	0	3190	5619	176	51	23.2	1.59
14	PP 005 AGRIDEX PP 005 AGRIDEX	0.25 1 qt. 0.25 1 qt.	OT OT LBY LBY	100	100	100	0	0	0	3354	5922	176	51	23.4	1.71
15	FUSILADE AGRIDEX FUSLIADE AGRIDEX	0.50 1 qt. 0.50 1 qt.	OT OT LBY LBY	99	100	100	0	0	0	3129	5570	178	50	17.9	1.80
16	CHECK CULT			13	0	0	0	0	0	3001	5286	175	48	22.6	1.68
		LSD.05		18	12	9	3	1	0	NS	NS	NS	NS	NS	NS
		CV (%)		16	11	8	276	270	0	9	10	2	11	18	15

[1] POT = Overtop postemerge when weeds are in the 1-2 leaf stage
OT = Overtop immediately after transplanting
LBY = Postemergence semi-directed after last cultivation.

[2] CG1 = Large crabgrass 1-3/sq. ft.
CG2 = Large crabgrass 1/sq. ft.
CG3 = Large crabgrass 1 sq. ft.

*Rate applied was 4 X that intended because of computer error.

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Table 6. Poast Herbicide Evaluation Test for Grass Control in Tobacco, Kinston, N. C. 1984

TR No.	TREATMENT	RATE lbs Ai/A	METHOD[1] APPLI.	% Injury (Stunting) May 14	June 12	July 14	Yield and Price Quality lbs/A	$/A	$/CWT	Grade Index Value	Chemical Constituents SU %	TA %
1	POAST AGRIDEX	0.2 1 qt/A	POT	0	0	0	2438	4255	175	52	9.6	2.58
2	POAST AGRIDEX	0.3 1 qt./A	POT	0	0	0	2479	4282	173	48	8.1	2.54
3	POAST AGRIDEX	0.4 1 qt/A	POT	0	0	0	2333	4222	175	53	10.8	2.77
4	POAST	0.2	POT	0	0	0	2403	4222	175	53	9.8	2.87
5	POAST	0.3	POT	0	0	0	2221	3877	175	49	10.7	3.00
6	POAST	0.4	POT	0	0	0	2370	4168	176	53	9.1	2.79
7	POAST AGRIDEX	0.2 1 qt/A	LBY	0	0	0	2579	4514	175	48	8.8	2.58
8	POAST AGRIDEX	0.3 1 qt/A	LBY	0	0	0	2403	4176	174	52	6.8	2.28
9	POAST AGRIDEX	0.4 1 qt/A	LBY	0	0	0	2636	4603	175	48	6.6	2.42
10	POAST	0.2	LBY	0	0	0	2687	4751	177	55	7.4	2.30
11	POAST	0.3	LBY	0	0	0	2327	4024	173	49	10.0	2.79
12	POAST	0.4	LBY	0	0	0	2682	4722	176	51	8.9	2.67
13	AGRIDEX	1 qt/A	POT	0	0	0	2630	4650	177	54	7.0	2.41
14	AGRIDEX	1 qt/A	LBY	0	0	0	2467	4276	177	54	9.7	2.64
15	POAST AGRIDEX POAST AGRIDEX	0.4 1 qt/A 0.4 1 qt/A	POT LBY	0	0	0	2534	4387	173	48	10.1	2.86
16	CULT CHECK			0	0	0	2326	4052	174	49	10.6	2.87
		LSD.05					NS	NS	NS	NS	NS	NS
		CU(%)					9	9	2	13	42	18

[1]POT = Overtop postemergence when weedsin the 1-2 leaf stage

LBY - Postemerge semi-directed after last cultivation.

Table 7. Poast Herbicide Evaluation for Grass Control Test in Tobacco, Rocky Mount, North Carolina 1984

TRT NO.	HERBICIDE	RATE LB/A	APPLI. METHOD	% Weed Control[2] CG1 May 31	CG2 July 15	CG3 Aug. 15	% INJURY INJ 1 May 15	INJ 2 July 15	INJ 3 Aug. 15	% YIELD AND QUALITY #/A	$/A	$/CWT	Grade Index Value	CHEMICAL CONSTICUENTS SU (%)	TA (%)
1	POAST AGRIDEX	0.20 1 qt.	POT POT	100	99	71	0	0	0	3643	6456	177	47	24.7	1.63
2	POAST AGRIDEX	0.30 1 qt.	POT POT	100	99	84	0	0	0	3636	6508	179	47	25.2	1.71
3	POAST AGRIDEX	0.40 1 qt.	POT POT	100	100	76	0	0	0	3656	6553	179	48	25.2	1.66
4	POAST	0.20	POT	100	100	83	0	0	0	3575	6304	176	50	25.7	1.66
5	POAST	0.30	POT	100	100	73	0	0	0	3796	6778	179	50	24.7	1.70
6	POAST	0.40	POT	100	100	85	0	0	0	3795	6788	179	46	24.9	1.60
7	POAST AGRIDEX	0.20 1 qt.	LBY LBY	0	99	73	0	0	0	3492	6222	.178	47	26.8	1.77
8	POAST AGRIDEX	0.30 1 qt.	LBY LBY	0	98	56	0	0	0	3825	6815	178	45	25.9	1.60
9	POAST AGRIDEX	0.40 1 qt.	LBY LBY	0	98	64	0	0	0	3438	6118	177	49	25.0	1.55
10	POAST	0.20	LBY	0	100	45	0	0	0	3444	6123	178	50	27.3	1.66
11	POAST	0.30	LBY	0	100	65	0	0	0	3721	6647	179	47	24.6	1.76
12	POAST	0.40	LBY	0	99	60	0	0	0	3553	6276	177	49	25.5	1.60
13	AGRIDEX	1.qt.	POT	0	43	30	0	0	0	3679	6543	178	48	26.1	1.60
14	AGRIDEX	1.qt.	LBY	0	40	0	0	0	0	3416	6143	180	51	25.4	1.50
15	POAST AGRIDEX POAST AGRIDEX	0.40 1.qt. 0.40 1.qt.	POT POT LBY LBY	100	100	85	0	0	0	3544	6403	181	47	26.2	1.79
16	CHECK CULT			13	43	35	0	0	0	3489	6201	178	46	25.2	1.49
			LSD.05	8	6	22	0	0	0	NS	NS	NS	NS	NS	NS
			CV (%)	14	5	27	0	0	0	9	9	2	6	6	14

[2]CG1 = Large crabgrass 1-3/sq. ft.
CG2 = Large crabgrass 1-3/sq. ft.
CG3 = Large crabgrass 1-10/sq. ft.

[1]POT = Overtop postemergence when weeds in the 1-2 leaf stage.
LBY = Postemergence semi-directed after last cultivation .

TABLE 8. EVALUATION OF WEED CONTROL WITH IMAZAQUIN, 1984.

Treatment	lb/A	Application Method	PERCENT CONTROL[2]				
			LQ	CG	CR	RP	MG
IMAZAQUIN	0.25	PBI	97	93	94	98	92
IMAZAQUIN	0.38	PBI	95	87	94	98	89
IMAZAQUIN	0.25	POBI	93	74	98	97	93
IMAZAQUIN	0.38	POBI	96	81	96	98	95
IMAZAQUIN	0.25	OT	96	92	93	97	95
IMAZAQUIN	0.38	OT	98	94	93	98	98
PENDIMETHALIN	1.0	PBI	89	94	80	94	87
IMAZAQUIN	0.25	E. POT	89	86		92	96
IMAZAQUIN	0.38	E. POT	87	83		92	95
IMAZAQUIN +PENDIMETHALIN	0.25 +1.0	E. POT	90	92		93	94

[1]PBI = prebed incorporated
POBI = postbed incorporated
OT = overtop immediately after transplanting
E. POT = early post overtop, about 2 weeks after transplanting

[2]Average of three locations, Clayton, Kinston and Reidsville, N. C.
LQ= Lambquarters, CG = Large Crabgrass, CR = Common Ragweed
RP = Redroot Pigweed, MG = Ivyleaf Morningglory.

TABLE 9. EFFECT OF IMAZAQUIN ON VIGOR AND YIELD OF TOBACCO, 1983 and 1984.

TABLE 9. EFFECT OF IMAZAQUIN ON VIGOR AND YIELD OF TOBACCO, 1983 and 1984.

TREATMENT	RATE lb/A	APPLICATION METHOD[1]	% VIGOR REDUCTION[2] 1983[3]	1984[4]	2 Yr./Av.	lb/A YIELD 1983[3]	1984[4]	2 Yr./Av.
IMAZAQUIN	0.25	PBI	54	69	62	2152	1296	1723
IMAZAQUIN	0.38	PBI	56	81	69	1955	946	1450
PENDIMETHALIN	1.0	PBI	3	4	4	2238	2619	2432
IMAZAQUIN	0.25	POBI	4	21	12	2121	2432	2276
IMAZAQUIN	0.38	POBI	5	30	18	2172	2287	2229
IMAZAQUIN	0.25	OT	16	24	20	2522	2167	2358
IMAZAQUIN	0.38	OT	25	26	26	2365	2107	2236
IMAZAQUIN	0.25	E. POT	21	3	12	2030	2607	2319
IMAZAQUIN	0.38	E. POT	22	10	16	1805	2358	2081
CONTROL			0	2	1	2160	2486	2323

[1]PBI = Prebed incorporated
POBI = Postbed incorporated
OT = Overtop immediately after transplanting
E. POT = Early post over top about 2 weeks after transplanting

[2] Based mainly on plant height and leaf expansion reduction

[3]1983 - average of two locations, Clayton and Reidsville

[4]1984 = average of three locations, Clayton, Reidsville and Kinston

TABLE 10. EFFECT OF IMAZAQUIN ON VIGOR AND YIELD OF TOBACCO, 1984.

TREATMENT	RATE lb/A	APPLICATION[1] METHOD	% VIGOR[2] REDUCTION	YIELD lb/A
IMAZAQUIN	0.25	SURFACE	11	2474
IMAZAQUIN	0.38	SURFACE	21	2274
IMAZAQUIN	0.25	SURFACE	7	2457
+ PENDIMETHALIN	+1.0	SURFACE		
CONTROL			2	2486
IMAZAQUIN	0.25	LBY	2	2379
IMAZAQUIN	0.38	LBY	0	2465
CONTROL			2	2486

[1]SURFACE = On surface of bed after knocking off top of bed
LBY = Semi-directed after last cultivation

[2]Average of three locations, Kinston, Clayton and Reidsville, North Carolina

Table 11. Summary of Burley Tobacco Herbicide On-Farm Tests, 1984.

TREATMENT	RATE lb. Ai/A	APPLI. METH.[1]	% OF WEED CONTROL FOR ALL LOCATIONS: Common Rag-Weed[2]	Quack grass[3]	Johnson grass	Smart weed[2]	Large Crab grass[2]	Common Pur-lane[4]	Hairy Galinsoga[5]	Common Lamb quarter[5]	Red Root Pigweed[4]	Common Cocklebur[4]	Tall M'glory[6]	Fall Panicum[3]	% Injury (Stunting)
1. PROWL	1.0	PBI	44	52	57	67	94	79	66	86	86	88	52	86	7
2. ENIDE	4.0	OT	55	30	70	75	90	77	77	72	72	30	16	79	0
3. ENIDE	6.0	OT	71	27	68	85	94	85	80	72	73	40	18	90	1
4. DEVRINOL	2.0	OT	58	62	32	84	91	76	83	63	64	38	19	89	2
5. PAARLAN	1.5	OT	52	70	83	74	91	67	53	83	83	37	9	78	3
6. CHECK			6	13	0	0	24	7	13	13	14	45	13	0	0
		LSD.05	23	52	40	16	28	20	19	19	16	NS	22	24	6
		CV (%)	27	58	27	15	20	23	30	29	27	65	60	13	139

[1] PBI = Prebed incorporated
OT = Overtop immediately transplanting

[2] Three locations

[3] One location

[4] Six locations

[5] Seven locations

[6] Two locations

TABLE 12. PRELIMINARY EVALUATION TEST OF CINCH HERBICIDE FOR TOBACCO – Rocky Mount and Reidsville, 1984

ROCKY MT. LOCATION			% CONTROL								
			Large Crabgrass[3]			Carpetweed[3]			% Injury (Stunting)		
TREATMENT	RATE	METHOD APPLICATION[1]	June 15	July 15	Aug. 15	June 15	July 15	Aug. 15	June 15	July 15	Aug. 15
CINCH	.75	OT	100	100	93	100	100	90	0	1	0
CINCH	1.0	OT	100	99	98	100	100	98	0	4	0
UNTREATED CHECK			25	52	41	0	52	65	0	4	0
REIDSVILLE LOCATION			Large Crabgrass[4]			Redroot Pigweed[4]			% Injury		
			June 19	July 18	Sept. 10	June 19	July 18	Sept. 10	June 17	June 18	Sept. 10
CINCH	.75	OT[2]	100	95	88	95	85	89	0	0	0
CINCH	1.0	OT	100	99	97	100	95	94	0	5	5
UNTREATED CHECK	–	–	25	50	60	50	55	76	0	0	0

1 Treatments applied 5-10-84, OT = Overtop immediately after transplanting

2 Treatments applied 5-28-84

3 Density – Large crabgrass 3-5/sq. ft. All Ratings
Carpetweed 1-3/sq. ft. First Ratings
<1/sq. ft. All other Ratings

4 Large crabgrass <1/sq. ft. for all ratings
Redroot pigweed <1/sq. ft.. for all ratings

Table 13. No-Till Tobacco Hercide Evaluation Test. Clayton, N. C. 1984.

TRT No.	HERBICIDE	RATE LB/A	APPLI.[1] METHOD	% WEED CONTROL[2] June 6 RW1	July 15 RW2	June 6 CG1	July 15 CG2	INJURY % of leaves Puckered June 6	YIELD & QUALITY #/A	$/A	$/CWT	INDEX VALUE	CHEMICAL CONSTITUENTS SU (%)	TA(%)
1	PARAQUAT SCEPTER	0.50 0.25	GK1 GK1	100	81	95	69	43	1414	2434	172	52	22.0	1.54
2	PARAQUAT SCEPTER	0.38 0.38	GK1 GK1	100	89	99	76	64	1355	2323	171	50	21.6	1.80
3	PARAQUAT SCEPTER	0.50 0.25	GK1 OT	100	88	86	74	43	1430	2430	170	53	23.7	1.60
4	PARAQUAT SCEPTER	0.50 0.38	GK1 OT	100	92	84	64	100	1541	2676	173	53	24.2	1.55
5	PARAQUAT SCEPTER	0.50 0.25	GK1 POT	86	85	65	61	100	1219	2104	170	53	21.5	1.49
6	PARAQUAT SCEPTER	0.50 0.38	GK	77	75	63	56	100	1484	2564	173	53	20.3	1.79
7	PARAQUAT SCEPTER FUSLIADE	0.50 0.25 0.25	GK1 POT POT	90	80	50	43	100	1498	2585	172	54	23.9	1.34
8	PARAQUAT SCEPTER FUSLIADE	0.50 0.38 0.25	GK1 POT POT	86	80	55	48	100	1382	2376	169	53	21.2	1.56
9	PARAQUAT COMMAND	0.50 1.00	GK1 GK1	90	88	90	76	0	1383	2371	171	56	21.3	1.73
10	PARAQUAT COMMAND	0.50 2.00	GK1 GK1	97	95	95	75	0	1409	2392	170	52	21.9	1.80
11	PARAQUAT COMMAND	0.50 1.00	GK1 OT	100	93	100	88	0	1655	2883	173	52	23.5	1.65
12	PARAQUAT COMMAND	0.50 2.00	GK1 OT	100	98	99	94	0	1833	3195	174	53	22.5	1.72
13	PARAQUAT ENIDE	0.50 6.00	GK1 GK1	68	50	70	35	0	795	1310	165	54	24.0	1.65
14	PARAQUAT ENIDE	0.50 6.00	GK1 OT	89	74	75	55	0	1537	2681	174	53	21.3	1.68
15	PARAQUAT WEEDY CHECK	0.50 0.00	GK1	8	25	33	0	0	1570	2723	173	53	23.7	1.35
			LSD.05	22	25	24	19	11	767	1396	96	NS	NS	NS
			CV (%)	19	22	22	23	22	26	27	2	4	10	17

[1] GK1 = Overtop rye for contact and preemergence control.
OT = Overtop immediately after translating
POT = Overtop postemergence after weeds are in the 1-2 leaf stage.

[2] CG1 = Large crabgrass <1 sq. ft.
CG2 = Large crabgrass 1-3 sq. ft.
RW1 = Common ragweed >10/sq. ft.
RW2 = Common ragweed >10/sq. ft.

TABLE 14. NO-TILL HERBICIDE EVALUATION TEST. REIDSVILLE, N. C., 1984.

TRT No.	HERBICIDE	RATE LB/A	APPLICATION[1] METHOD	% WEED CONTROL[2] RW1 June 7	RW2 July 20	SW1 June 7	SW2 July 20	INJURY June 7	YIELD lbs/10 PLANTS GREEN WEIGHT August 13
1	PARAQUAT SCEPTER	0.50 0.25	GK1 GK1	53	37	37	7	0	3.7
2	PARAQUAT SCEPTER	0.38 0.38	GK1 GK1	53	43	43	10	0	4.7
3	PARAQUAT SCEPTER	0.50 0.25	GK1 OT	93	82	82	82	0	10.0
4	PARAQUAT SCEPTER	0.50 0.38	GK1 OT	92	83	83	83	0	8.3
5	PARAQUAT SCEPTER	0.50 0.25	GK1 POT	88	78	78	83	0	8.0
6	PARAQUAT SCEPTER	0.50 0.38	GK1 POT	88	78	78	78	0	7.0
7	PARAQUAT SCEPTER	0.50 0.25	GK1 POT	92	85	85	83	0	8.0
8	PARAQUAT SCEPTER FUSLIADE	0.50 0.38 0.25	GK1 POT POT	97	92	92	87	0	9.3
9	PARAQUAT COMMAND	0.50 1.00	GK1 GK1	90	90	90	75	0	7.0
10	PARAQUAT COMMAND	0.50 2.00	GK1 GK1	100	93	93	93	0	5.0
11	PARAQUAT COMMAND	0.50 1.00	GK1 OT	87	85	85	87	0	7.3
12	PARAQUAT COMMAND	0.50 2.00	GK1 OT	93	80	80	40	0	7.8
13	PARAQUAT ENIDE	0.50 6.00	GK1 GK1	43	27	27	13	0	7.7
14	PARAQUAT ENIDE	0.50 6.00	GK1 OT	57	48	48	43	0	5.3
15	PARAQUAT WEEDY CHECK	0.50 0.00	GK1	23	3	3	17	0	3.3
			LSD.05	37	6	39	8	-	NS
			CV (%)	27	30	32	35	-	44

[1] GK1 = Overtop rye for contact and preemergence control
OT = Overtop immediately after transplanting
POT = Overtop postemerge when weeds are 1-2 leaf stage.

[2] RW1 = Common ragweed 1/sq. ft.
RW2 = Common ragweed 1/sq. ft.
SW1 = Penn. smartweed 3-5/sq. ft.
SW2 = Penn. smartweed 3-5/sq. ft.

TABLE 15. FERTILIZATION

[1]GK1 = Overtop rye for contact and preemergence control
OT = Overtop immediately after transplanting
POT = Overtop postemerge when weeds are 1-2 leaf stage.

RW2 = Common ragweed 1/sq. ft.
SW1 = Penn. smartweed 3-5/sq. ft.
SW2 = Penn. smartweed 3-5/sq. ft.

TABLE 15. FERTILIZATION TEST IN NO-TILL AND CONVENTIONAL TOBACCO - CLAYTON and REIDSVILLE, 1984

		CLAYTON LOCATION					REIDSVILLE LOCATION					
TR NO.	FERTILIZER TREATMENTS[1]	CULTURAL METHOD	lbs/A	$/A	$/CWT	GRADE INDEX	lbs/A	$/A	$/CWT	GRADE INDEX	Chem. Constituents SU(%)	TA(%)
1	Standard (base plus sideress) (60-65 # N)	No-till	1683	2931	174.17	52	1277	2179	173	43	13.8	1.57
2	1/2 X increase (base + sidedress) (85-90 # N)	No-till	1401	2391	169.65	53	819	1380	169	46	18.0	1.09
3	2X increase (base + sidedress) (110-120 # N)	No-till	1415	2424	171.17	53	1059	1831	173	51	21.4	.74
4	Broadcast/Standard Base + sidedress (60-65 #N)	No-till	1130	1942	170.95	52	355	571	161	47	17.7	.59
5	Broadcast, 1/2X increase base + sidedress (85-90 #N)	No-till	1212	2120	172.59	55	-	-	-	-	-	-
6	Broadcast 2X increase base + sidedress (110-120 #N)	No-till	1620	2860	176.59	50	1101	1862	169	48	17.1	1.58
7	Standard (base + sidedress (60-65 # N)	Conv.	2362	4243	179.69	51	2053	3589	175	50	17.6	1.57
8	1/2X increase base + sidedress (85-90 # N)	Conv.	2062	3630	176.02	51	1795	3124	172	46	17.3	1.74
9	2X increase base plus sidedress (110-120 #N)	Conv.	2262	4040	179.52	50	2258	3995	177	53	16.4	2.06
10	Broadcast standard base + sidedress (60-65 #N)	Conv.	2248	4012	178.52	53	1765	3162	178	59	17.1	1.82
11	Broadcast 1/2X increase base + sodedress (85-90 #N)	Conv.	2293	4144	180.72	53	-	-	-	-	-	-
12	Broadcast 2X increase base + sidedress (110-120 #N)	Conv.	2369	4265	180.03	52	2402	4309	179	48	1.46	2.14
		LSD.05	342	634	5.76	NS	326	634	12	NS	NS	0.50
		%CV	12	12	1.8	8	14	16	3	15	23	20

[1]All plots of no-till sprayed with .5 lb a.i./A paraquat plus 3 lb/A Enide at GK1 + 3# Enide OT after transplanting.
Conv. plots received 4 lb/A Enide OT + 2 cultivation.

TABLE 16. BURLEY TOBACCO NO-TILL vs. CONVENTIONAL HERBICIDE TEST, WAYNESVILLE, NORTH CAROLINA, 1984

TR NO.	TREATMENTS	RATE	METHOD[1] APPLICATION	CULTURAL PRACTICE	% WEED CONTROL[2] COMMON LAMBSQUARTER June 27	LARGE CRABGRASS June 27	% INJURY (STUNTING) June 27	AVE. YIELD AND QUALITY[3] #/A	$/A	$/CWT
1	PARAQUAT	.5	GK1	No-till	100	100	0			
	COMMAND	1.0	GK1							
	COMMAND	1.0	OT							
2	PARAQUAT	.5	GK1	No-till	100	100	20	2281	4306	189
	SCEPTER	.38	GK1							
	SCEPTER	.38	OT							
3	PARAQUAT	.5	GK1	No-till	100	100	0			
	ENIDE	3.0	GK1							
	ENIDE	3.0	OT							
4	COMMAND	1.0	OT	Conv.	100	100	0			
5	SCEPTER	.38	OT	Conv.	100	100	0	2474	4675	189
6	ENIDE	6.0	OT	Conv.	95	100	0			
				LSD.05	NS		.8	NS	NS	NS
				% CV	6	-	67	14	14	.26

[1] GK1 = Applied to rye for grain kill at 20.1 g.p.A
OT = Applied overtop immediately after transplanting at 20.1 g.p.A

[2] Common Lambsquater = 1/sq. ft.
Large Crabgrass = 1/sq. ft.

[3] Because of heavy etch virus infestitation, yield and quality value were obtained by harvesting 20 plants from an area in each plot possible that was least affected by virus. Since sufficient replications could not be obtained for each herbicide treatment, plots harvestable were pooled for each cultural practice, making 8 replications each per cultural practice.

Table 1. Detailed Plot and Application for Tobacco Herbicide Evaluation Test, Kinston, N. C., 1984

PLOT INFORMATION

1. Crop Variety: K326
2. Transplanting Dates: 4-15-84
3. Plot Size: 3 Rows (2 Treated, 1 Border) 20 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 24 Plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Lynchburg Sandy Loam
10. Percent Organic Matter: 0.9
11. Soil pH: 6.4
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: PBI, SUR, OT = 20.1 GPA LBY = 18.3 GPA
15. Pressure (PS1): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 20"
19. Nozzles Spacing:
20. Application details:

Application Date	Method of Application	Weeds Present and Density
4-13-84	PBI	None
4-13-84	Sur	None
4-25-84	OT	None
6-18-84	LBY	<1 Lambsquarter/Sq. Ft. (Seeded)

Table 2. Detailed Plot and Application Data for Tobacco Herbicide Evaluation Test, Rocky Mount, N. C., 1984

PLOT INFORMATION

1. Crop Variety: McNair 944
2. Transplanting Dates: 5-9-84
3. Plot Size: 3 Rows (1 Border, 2 Treated) X 20 ft
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 24 Plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Shubata Loamy Sand
10. Percent Organic Matter: 10
11. Soil pH: 6.6
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: PBI, Sur, OT = 20.1/GPA LBY = 18.3 GPA
15. Pressure (PSI): 20
16. Type Nozzle: Whirl-Chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application Date / Method of Application / Weeds Present and Density

Application Date	Method of Application	Weeds Present and Density
5-7-84	PBI	None
5-7-84	SUR	None
5-10-84	OT	None
6-11/84	LBY	Large crabgrass <1sq. ft. 10cc diameter. Carpet.weed <1/sq. ft. mature.

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Table 3. Detailed Plot and Application Data for Postemergence Herbicide Evaluation Test in Tobacco, Reidsville, N. C., 1984

PLOT INFORMATION

1. Crop Variety: NC/82
2. Transplanting Dates: 5-24-84
3. Plot Size: 3 Rows (1 Treated, 2 Borders) X 45 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 44 Plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Cecil Clay Loam
10. Percent Organic Matter: 0.9
11. Soil pH: 6.5
12. Type Sprayer: CO_2 packpack
13. Diluent/Carrier: H_2O
14. Spray Volume: OT, POT = 20.1, LBY = 18.3 gpA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 x 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application Date

Application Date	Method of Application	Weeds Present and Density
6-4-84	OT	Emerging to 1-leaf stage
6-20-84	POT	Large crabgrass 1-5/sq. ft. 2-5 leaf stage
7-11-84	LBY	Large crabgrass <1/sq. ft. 5-6 leaf stage

Table 4. Detailed Plot and Application Data for Postemergence Herbicide Evaluation Test in Tobacco, Rocky Mt. N. C., 1984

PLOT INFORMATION

1. Crop Variety: McNair 944
2. Transplanting Dates: 5-9-84
3. Plot Size: 3 Rows (2 treated, 1 border) X 20 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 24 plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Shubata Loamy Sand
10. Percent Organic Matter: 1.0
11. Soil pH: 6.6
12. Type Sprayer: CO_2
13. Diluent/Carrier: H_2O
14. Spray Volume: OT, POT = 20.1 LBY = 18.3 gpa
15. Pressure (PSI): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20.

Application Date	Method of Application	Weeds Present and Density
5-10-84	OT	None
5-22-84	POT	Large crabgrass 1-3/sq. ft 1-2 leaf stage
6-11-84	LBY	Large crabgrass <1/sq. ft. 10 cc diameter

Table 5. Detailed Plot and Application Data for Poast Herbicide Evaluation Test in Tobacco, Kinston, N. C., 1984

PLOT INFORMATION

1. Crop Variety: K/326
2. Transplanting Dates: 4/24-84
3. Plot Size: 3 Rows (2 treated, 1 border) x 20 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 24 plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Lynchburg sandy Loam
10. Percent Organic Matter: .9
11. Soil pH: 6.4
12. Type Sprayer: CO_2
13. Diluent/Carrier: H_2O
14. Spray Volume: POT = 20.1 LBY = 18.3 GPA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 x 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application Date / Method of Application / Weeds Present and Density

Application Date	Method of Application	Weeds Present and Density
5-31-84	POT	None
6-18-84	LBY	None

Table 6. Detailed Plot and Application Data for Poast Herbicide Evaluation Test in Tobacco, Rocky Mount, N. C., 1984

PLOT INFORMATION

1. Crop Variety: McNair 944
2. Transplanting Dates: 5-9-84
3. Plot Size: 3 Rows (2 Treated, 1 Border) X 20 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 24 plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Shubata Loamy Sand
10. Percent Organic Matter: 1.0
11. Soil pH: 6.6
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: POT = 20.1 gpA LBY = 18.3 gpA
15. Pressure (PSI): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application Date / Method of Application / Weeds Present and Density

Application Date	Method of Application	Weeds Present and Density
POT 5-22-84	POT	Large crabgrass 1-3/sq. ft. 1-2 leaf stage
LBY 6-11-84	LBY	Large crabgrass <1/sq. ft. 10 cc diameter

Table 7. Detailed Plot and Application Data for NO-Till Tobacco Herbicide Evaluation Test, Reidsville, N. C., 1984

PLOT INFORMATION

1. Crop Variety: NC/82
2. Transplanting Dates: May 24, 1984
3. Plot Size: 3 Rows (2 Treated, 1 Border) X 42 Ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 40 plants/plot
7. Experimental Design: RCB
8. Replications: 3
9. Soil Type: Cecil Clay Loam
10. Percent Organic Matter: 0.9
11. Soil pH: 6.6
12. Type Sprayer: CO_2
13. Diluent/Carrier: H_2O
14. Spray Volume: At grain-kill (GKl), OT, POT = 20.1 gpA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application Date / Method of Application / Weeds Present and Density

Application Date	Method of Application	Weeds Present and Density
May 16	GKl	Rye 4 to 6 ft.
May 24	OT	None
June 5	POT	Common Ragweed <1 sq. ft. Penn Smartweed 1-3/sq. ft.

Table 8. Detailed Plot and Application Data for No-Till Tobacco Herbicide Evaluation Test, Clayton, N. C., 1984

PLOT INFORMATION

1. Crop Variety: McNair 944
2. Transplanting Dates: May 1 & 2
3. Plot Size: 3 Rows (1 Boarder, 2 Treated) X 45 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 44 plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Gilead Sandy Loam
10. Percent Organic Matter: 1.1
11. Soil pH: 6.5
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: at Grain-Kill (GKI), OT, POT = 20.1 GPA
15. Pressure (PS1): 20
16. Type Nozzle: whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20.

Application Date	Method of Application	Weeds Present and Density
April 19	GKI	Rye 4-6 ft. tall
May 3	OT	
June 1	POT	

Table 9. Detailed Plot and Application Data for Fertilization Test in No-Till and Conventional Tobacco, Calyton, N. C. 1984

PLOT INFORMATION

1. Crop Variety: McNair 944
2. Transplanting Dates: May 1, 1984
3. Plot Size: 2 Rows (No Border) by 45 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 40 plants/plot
7. Experimental Design: RCB
8. Replications: 3 Reps
9. Soil Type: Gilead Sandy Loam
10. Percent Organic Matter: 11
11. Soil pH: 6.5
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: GK1, OT = 20.1 gpA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl Chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application

Application	Method of Application	Weeds Present and Density
April 19	GK1 (Paraquat)	Rye 4-6 ft. tall
May 3	OT (Enide)	

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Table 10. Detailed Plot and Application Data for Fertilization Test in No-Till and Conventional Tobacco, Reidsville, N. C., 1984

PLOT INFORMATION

1. Crop Variety: NC/82
2. Transplanting Dates: May 24, 1984
3. Plot Size: 2 Rows (No Border) X 42 Ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 40 plants/plot
7. Experimental Design: RCB
8. Replications: 3
9. Soil Type: Cecil Clay Loam
10. Percent Organic Matter: 0.9
11. Soil pH: 6.6
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: grain-kill 1 (GK1), OT = 20.1 gpA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 X 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20.

Application Date	Method of Application	Weeds Present and Density
May 12	GK1 (paraquat)	Rye 4 to 6 ft tall
May 24	OT (Enide)	None

nd

Table 11. Detailed Plot and Application Data for No-Till vs. Conventional Burley Tobacco Test, Waynesville, N. C., 1984.

PLOT INFORMATION

1. Crop Variety: Kentucky 14
2. Transplanting Dates: June 7, 1984
3. Plot Size: 3 Rows (1 Border, 2 Treated) x 35 ft.
4. Row Spacing: 45"
5. Plant Spacing: 22"
6. Stand Establishment: 40 plants/plot
7. Experimental Design: RCB
8. Replications: 4
9. Soil Type: Dyke Clay Loam
10. Percent Organic Matter: 1.2
11. Soil pH: 6.2
12. Type Sprayer: CO_2 backpack
13. Diluent/Carrier: H_2O
14. Spray Volume: At grain-kill (GKl) and OT = 20.1 gpA
15. Pressure (PSl): 20
16. Type Nozzle: Whirl-chamber
17. Nozzle Size: 49 x 49
18. Nozzles/Row: 2 1/2
19. Nozzles Spacing: 20"
20. Application

Application	Method of Application	Weeds Present and Density
May 17	GKl	Rye 4-6 ft. tall
June 7	OT	

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Table 12. RAINFALL, Clayton, 1984

Date	April	May	June	July	August
1	0	0	0	0	.43
2	0	.56	0	0	0
3	0	.06	0	0	0
4	.05	0	0	.20	0
5	.97	0	0	.13	0
6	0	.07	0	0	0
7	0	.18	0	.42	0
8	0	.72	0	0	0
9	0	0	0	0	0
10	.89	0	0	0	2.08
11	.22	0	0	0	.22
12	0	0	0	.89	.12
13	0	0	0	0	0
14	.46	0	0	1.68	.09
15	.60	0	0	1.45	0
16	.10	0	0	1.01	0
17	0	0	.19	.67	0
18	0	0	.06	1.18	0
19	.19	0	.99	0	.06
20	0	0	.51	0	0
21	0	0	0	0	0
22	.76	0	0	.53	0
23	.60	.40	.11	.09	0
24	0	0	0	0	.53
25	0	0	0	0	0
26	0	0	0	0	0
27	0	0	0	0	0
28	0	.42	1.19	.30	0
29	0	.26	.83	2.13	0
30	.14	1.94	.68	.09	.09
31		.22		.24	.09
TOTAL	4.98	4.83	4.56	11.01	3.71

Table 13. RAINFALL - Rocky Mount, 1984

Date	April	May	June	July	August
1	0	.10	0	.36	.28
2	0	0	0	0	0
3	0	.37	0	T	0
4	.17	.05	.16	0	0
5	.77	0	0	T	0
6	0	0	0	0	0
7	T	1.00	.08	.03	0
8	0	.64	0	.18	0
9	T	.42	0	0	0
10	.44	0	0	0	.62
11	.10	0	0	T	.04
12	0	0	0	0	0
13	0	0	0	1.95	0
14	0	0	0	.53	0
15	.22	T	0	T	0
16	.54	0	0	0	0
17	.05	0	0	.81	0
18	0	0	T	.34	0
19	T	0	.05	.78	.04
20	.08	0	0	T	0
21	0	0	0	.04	0
22	T	0	0	2.00	0
23	1.63	0	0	.16	0
24	.02	.46	0	T	1.25
25	0	0	.04	.04	0
26	0	0	0	0	0
27	0	0	0	.35	0
28	0	1.57	0	.45	0
29	0	1.00	1.33	1.17	0
30	0	3.14	.20	.17	0
31	0	.31		T	0
TOTAL	4.02	9.06	1.86	9.36	2.23

Table 14. RAINFALL - Waynesville, 1984

Date	May	June	July	August	September
1	0	0	0	.15	0
2	.85	0	.11	0	0
3	1.18	0	.05	0	0
4	.38	0	0	0	.01
5	0	0	.88	T	0
6	1.61	0	.03	.01	0
7	1.81	.05	.03	T	0
8	1.71	0	0	0	0
9	0	0	0	1.70	0
10	0	0	0	0	0
11	0	.06	0	.81	0
12	0	T	.82	T	T
13	0	.03	.11	1.17	0
14	.05	.41	0	.19	0
15	0	.02	0	0	0
16	0	.16	T	.02	0
17	0	.14	.24	0	0
18	0	.04	.58	.31	0
19	0	0	0	0	0
20	0	.62	T	0	0
21	T	.25	.07	T	0
22	.10	1.56	0	0	0
23	.03	0	0	.20	0
24	0	.75	0	0	0
25	0	0	T	.02	0
26	T	0	1.03	0	0
27	.36	.03	.15	0	0
28	.10	T	.44	.07	0
29	.27	.35	.08	T	.02
30	0	1.57	.75	.13	.20
31	0		.20	.01	
TOTAL	8.45	6.04	5.57	4.79	.23

RAINFALL

Kinston, 1984

Table 15.

Date	April	May	June	July	August
1	0	.27	0	0	.98
2	0	0	0	.25	0
3	0	.42	0	.25	0
4	.14	.10	0	0	0
5	.47	0	0	0	0
6	0	.10	.06	0	0
7	0	.33	0	1.88	0
8	0	.30	0	0	0
9	0	1.20	0	0	0
10	.88	0	0	0	.87
11	0	0	0	0	.20
12	0	0	0	0	0
13	0	0	0	1.81	0
14	0	0	0	.33	0
15	0	0	0	0	0
16	.43	0	0	.02	0
17	0	0	.72	2.22	0
18	0	0	0	.94	0
19	0	0	0	.18	0
20	.02	0	0	0	1.56
21	0	0	0	.63	0
22	0	0	0	0	0
23	.93	.21	0	0	.02
24	0	.45	.47	.88	.68
25	0	0	0	0	0
26	0	0	0	0	0
27	0	.05	0	.44	0
28	0	0	1.08	.99	.01
29	0	0	.27	.15	.01
30	0	2.23	0	0	0
31		.27		0	.35
TOTAL	2.87	5.93	2.60	10.97	4.67

Table 16. RAINFALL - Reidsville, 1984

Date	May	June	July	August	September
1	0	0	.78	.09	0
2	0	0	0	.07	0
3	.17	0	.08	0	0
4	.63	0	0	0	.05
5	T	0	1.21	.06	0
6	.11	0	.31	0	0
7	.27	0	.34	.03	0
8	.27	0	0	0	0
9	.08	0	T	0	0
10	0	0	.12	.65	0
11	0	0	.17	1.80	0
12	0	0	.41	1.63	0
13	0	0	.02	.19	0
14	0	0	1.03	.22	0
15	0	.17	0	0	0
16	0	.29	0	0	0
17	0	T	0	0	0
18	0	.38	3.34	0	0
19	0	0	.29	T	0
20	0	0	0	0	0
21	0	0	T	0	0
22	0	0	.26	0	0
23	.12	0	.09	0	0
24	.43	0	0	0	0
25	0	0	0	.03	0
26	0	0	.17	0	0
27	.82	0	.18	0	0
28	1.80	0	1.95	0	0
29	.23	1.63	.29	0	0
30	.25	.17	.11	0	0
31	0		0	1.01	0
TOTALS	5.18	2.64	11.15	5.78	.05

2000269777

NC05539 - Nicotiana tabacum Carbohydrate Biochemistry

David Danehower, Project Leader

I. Summary of Research:

A. Introduction

1984 marked the second year of this research project. The goals of this research have been:

1. Development of a rapid analytical method for the sucrose esters, a novel class of leaf surface components which play a significant role in tobacco flavor and aroma chemistry.

2. Screening of several U.S. and South American tobacco cultivars for sucrose ester content as well as for other exogenous (duvanes and labdanes) and endogenous compounds. This screening is designed to examine changes in component levels as a function of genotype, stalk position, age, and curing regimen.

The rationale for this research is to provide a base of data on tobacco chemistry upon which further experiments can be founded. These experiments include examination of alternative cultural and curing practices as they relate to tobacco flavor chemistry.

B. Summary of Progress

1.a. Sucrose Ester Analytical Method - Introduction

Development of the sucrose ester assay is near completion. As mentioned in the previous report, a high performance liquid chromatographic (HPLC) technique was originally developed for this assay. Due to the extensive sample preparation necessary for this type of analysis, this approach has been abandoned in favor of a capillary gas chromatographic (GC) method. This method requires much less sample preparation and is amenable to large numbers of samples.

1.b. Sucrose Ester Analysis - Materials and Methods

Field Sampling

Select a minimum of three uniform plants from each plot. Pull leaves by stalk position and place in large bags over dry ice. Repeat the process for all stalk positions and plots sampled. It is recommended that a minimum of three replications be used. Transport leaf tissue to the laboratory as soon as possible.

Laboratory Sampling

Using a leaf punch (at least 1.5 cm in diameter), remove disks from leaves at a point approximately midway between the tip and base of the leaf and about 3 cm. from the midrib. Collect a minimum of 10 disks and transfer with tweezers to teflon capped vials with appropriate labels. Add 1.0 ml of CH_2Cl_2 per disk to each vial and cap. Vortex sample for 30 seconds and remove disks. Transfer disks to a second vial and repeat the process. Remove and discard leaf disks. Combine extracts, add Na_2SO_4, and store in freezer.

Sample Preparation and Analysis

Sample preparation is carried out using a Waters' Silica Gel Sep-pak attached to a three way valve and a gas tight syringe (see Eskins and Duhon (1979) Anal. Chem. 51:1885). The sample is drawn into the syringe, the valve is switched and the sample is forced through the sep-pak. Eluant is collected in teflon capped vials or test tubes. The procedure is repeated after washing the vial with 5 ml of CH_2Cl_2. 10 ml of CH_2Cl_2 is then eluted through the sep-pak cartridge. The CH_2Cl_2 eluant is either discarded or can be used for analysis of hydrocarbons and other leaf surface components. 10 ml of CH_3OH is then drawn into the syringe, forced through the cartridge, and the eluant is collected in a teflon capped test tube containing 1.00 ml of a 50 microgram/ml solution of sucrose octa-acetate. The sample is then evaporated to dryness and derivatized with 50 microliters of a 1:1 BSTFA : DMF solution under N_2 gas at 75°C for 30 minutes.

Analysis of the resulting solution is carried out isothermally at 290°C using a 20 meter DB-5 capillary column. Injector temperature is 250°C and detector temperature is 300°C. The sucrose esters elute in approximately 20 minutes.

2. Leaf Surface and Endogenous Chemistries of U.S. and South American Genotypes

A number of U.S., South American, and oriental tobacco genotypes were grown at the Border Belt Tobacco Research Station during the summer of 1984. These genotypes included McNair 944, Burley 17, Galpao, Amberlinja, Brasil Special, and Samsun tobaccos. Each of these materials have unique exogenous and endogenous chemistries, and are cured in a variety of ways in the areas where they are grown. The goal of this experiment is to examine the chemistries of these plants under typical cultural and fertility regimens as well as during curing, so as to establish a comprehensive data base on which to build aditional experiments. Among our interests in this regard are:

1) how endogenous and leaf surface compounds change during growth, maturation and curing

2) the role of curing in these changes and the optimization of curing practices so as to minimize loss of flavor and aroma components

3) the possible use of South American genotypes in U.S. flue-cured tobacco breeding programs

II. A. Graduate Students:

None

B. Special Students:

Ms. Susan Danchi undertook an Honors Research Program in the spring of 1984. Topic of Research: "Modification of the Brockerhoff Method of Stereospecific Triglyceride Analysis."

III. Postdoctoral Fellows:

None

IV. Publications:

Danehower, D. A. and Bordner, J. (1984)
Cuticular Wax of Epilachna varivestis
J. of Insect Biochemistry 14(6):671-676.

V. Manuscripts Accepted for Publication:

Danehower, D. A. and Bordner, J. (1985)
Cuticular Fatty Acids of Epilachna varivestis.
J. of Insect Biochemistry. In Press.

IV. Manuscripts in Review:

None

VII. Papers Presented at Professional Meetings:

Danehower, D. A. Examination of Cuticular Waxes by Thin Layers Densitometry. South Eastern Branch E.S.A. January 31, 1985. Greenville, S.C.

VIII. Graduate Student Theses:

None

IX. Acknowledgements:

The project leader is deeply appreciative of the support and advice of the following individuals: Drs. R. C. Long, W. W. Weeks, E. A. Wernsman, J. A. Weybrew, as well as Mr. T. A. Bartholomew, Anne A. Dudley, George Clark and Kimble Brock.

2000269781

Title: Regulation of Carbon and Nitrogen Assimilation in Tobacco

Project Leader: Thomas W. Rufty, Jr.

I. Summary of Research:

The purpose of this physiology research project is to develop an understanding of important factors involved in regulation of carbon and nitrogen assimilation in tobacco. Studies are conducted at cell, tissue, and whole-plant levels of organization, and commonly include other plant types to determine if regulatory effects apply to crop plants in general.

A series of experiments was conducted to examine enzyme control of the partitioning of photosynthetically fixed carbon between starch and sucrose in leaves. Partitioning was altered using source-sink manipulations, different photoperiods, and cool aerial temperatures. In each instance, changes in the formation of sucrose and export of assimilates out of leaves were accompanied by proportional alterations in the activity of sucrose phosphate synthase. The results collectively support previous contentions that this enzyme plays a key role in controlling leaf carbohydrate biosynthesis.

Another series of experiments examined alterations in whole-plant partitioning of carbohydrate in response to nitrogen stress. A larger proportion of the plant content of carbohydrate and reduced nitrogen was allocated to roots with increasing nitrogen stress. The allocation pattern reflected considerable remobilization out of the leaf canopy. The alteration in partitioning was interpreted as evidence for significant source-sink adjustment and the involvement of secondary effects, e.g. those exerted by growth regulators and changes in hydraulic conductivity.

An additional investigation was begun to evaluate changes in plant energy status and nitrogen assimilation efficiency during the normal light-dark cycle. The initial experiments used ^{15}N labeled NO_3^- to define diurnal patterns in NO_3^- transport and reduction. The $^{15}NO_3^-$ uptake rate by plants was similar in the light and dark; however, reduction during the dark uptake period was 46% of that in the light. The lower rate of reduction in the dark was associated with both substantial retention of absorbed $^{15}NO_3^-$ in roots and decreased efficiency of reduction of $^{15}NO_3^-$ in the shoot. A large portion of the $^{15}NO_3^-$ retained in the root in darkness was translocated and incorporated into insoluble reduced-N in the shoot in the following light period, at a rate which was similar to the rate of whole-plant reduction of $^{15}NO_3^-$ acquired during the light period. Taking into account reduction of NO_3^- from all endogenous pools, it was apparent that plant reduction in a given light period exceeded considerably the rate of acquisition of exogenous substrate.

II. Graduate Students: None

III. Postdoctoral Fellows: None

IV. Publications:

Rufty, T. W., Jr., S. C. Huber, and P. S. Kerr. 1984. Effects of canopy defoliation in the dark on the activity of sucrose phosphate synthase. Plant Sci. Lett. 34:247-252.

Huber, S. C., T. W. Rufty, Jr., and P. S. Kerr. 1984. Effect of photoperiod on photosynthate partitioning and diurnal rhythms in sucrose-P synthase activity in leaves of soybean and tobacco. Plant Physiol. 75:1080-1084.

Rufty, T. W., Jr., C. D. Raper, Jr., and S. C. Huber. 1984. Alterations in internal partitioning of carbon in soybean plants in response to nitrogen stress. Can. J. Bot. 62:501-508.

Huber, S. C., D. C. Doehlert, T. W. Rufty, Jr., and P. S. Kerr. 1984. Regulation of sucrose phosphate synthase activity in leaves. In Photosynthesis, Proc. 6th Int. Congr. Photosynthesis. Vol. III. pp. 605-608.

Rufty, T. W., Jr., D. W. Israel, and R. J. Volk. 1984. Assimilation of $^{15}NO_3^-$ taken-up by plants in the light and in the dark. Plant Physiol. 76:769-775.

V. Manuscripts Accepted for Publication:

Rufty, T. W., Jr., S. C. Huber, and P. S. Kerr. Association between sucrose-phosphate synthase activity in leaves and plant growth rate in response to altered aerial temperature. Plant Sci. Lett., In Press.

Kerr, P. S., T. W. Rufty, Jr., and S. C. Huber. Endogenous rhythms in photosynthesis, sucrose-phosphate synthase activity, and stomatal resistance in leaves of soybean. Plant Physiol., In Press.

Huber, S. C., P. S. Kerr, and T. W. Rufty, Jr. Diurnal changes in sucrose-P synthase activity in leaves. Physiol. Plantarum, In Press.

VI. Manuscripts in Review: None

VII. Papers Presented at Professional Meetings:

Rufty, T. W., Jr., D. W. Israel, and R. J. Volk. Whole-plant assimilation of $^{15}NO_3^-$ absorbed in the light or dark. Annual Meeting of the American Society of Plant Physiologists at Univ. of California, Davis. August 12-17, 1984.

Kerr, P. S., S. C. Huber, D. W. Israel, and T. W. Rufty, Jr. Relations between photosynthate provision and plant growth. Annual Meeting of the American Society of Plant Physiologists at Univ. of California, Davis. August 12-17, 1984.

Huber, S. C., T. W. Rufty, Jr., and P. S. Kerr. Photosynthate partitioning and activity of sucrose phosphate synthase in response to photoperiod alteration in soybean and tobacco. Annual Meeting of the American Society of Plant Physiologists at Univ. of California, Davis. August 12-17, 1984.

VIII. Graduate Student Theses Completed During Reporting Period: None

IX. Acknowledgements:

Appreciation is extended to William G. Woodlief for excellent technical assistance.

Title: Burley Tobacco On-Farm Tests

Project Leader: R. L. Davis

I. Summary of Research:

This project has the following objectives:

A. To test rates, timing, sequential applications, and combinations of various sucker control chemicals on burley tobacco.

B. To evaluate the performance of available burley varieties and hybrids under the varying conditions that occur in western North Carolina.

C. To evaluate the effects of supplemental heat in curing burley tobacco.

Burley Tobacco On-Farm Test Results 1984

The effect of seasonal conditions on the growth and subsequent yield and quality of burley tobacco is very pronounced. The difference in yield between a good and a poor growing season, when other factors are held constant, may vary as much as one thousand pounds per acre or even more.

During the major portion of the growing season in 1984, the burley crop had adequate to excess moisture. Plants were large but leaves were thin bodied and overall yields were somewhat low. Quality of the cured crop was fair to good over most of the burley area in western North Carolina. The income from the 1984 crop will be in excess of $40 million dollars. Values in this report are based on 1984 advance prices by grades.

Sucker Control

Tobacco growth was good over most of the area and sucker pressure was moderate to heavy. Some degree of water damage was evident at several test sites which resulted in uneven growth. A few locations were abandoned for test purposes where conditions were rather severe.

The application of chemicals was difficult because of continual rains. Chemicals were reapplied on some tests where wash off by rain occurred immediately after application. At some other sites, rain reduced the effectiveness of chemicals. Sucker control was very good at locations where no rain fell for a period of 5 or 6 hours after application.

Several companies provided sucker control materials for use in these tests. All of the various forms, different concentrations, and different rates could not be fitted into a standard size field plot. Consequently, three sets of chemicals were used and labeled as Codes 1, 2, or 3. The treatments and codes are given in the accompanying tables.

Sucker growth was moderate to heavy at most test locations. A few cooperators harvested early (less than three weeks after topping) which resulted in very light sucker growth.

A new chemical, Bud Nip, was used in the burley on-farm tests for the first time this season. Bud Nip was provided by PPG Industries, Inc. and was applied under an experimental use permit since it does not have a full label for burley. It is systemic in action and was applied in the same manner as MH except it was mixed with water to form 40 gallons of solution. All other chemicals in these tests were mixed at rates to provide 50 gallons of solution per acre.

Bud Nip was applied as a sequential treatment following an earlier application of contact. It gave excellent sucker control at both rates used under the conditions encountered in these tests (cool and cloudy). Under hot, dry conditions, it was performed less well in the Regional Sucker Control Tests. Bud Nip exhibits a side effect of causing the top leaves to wrinkle and droop and some leaves will turn yellow. No adverse effect on yield or quality was noted, however.

The two applications of Off-Shoot-T in Treatment 3 of Code 1 were not applied. Selected sites were either delayed by rain until too late to apply both treatments or were discarded because of water damage. Two applications of contact alone (Treatment 3, Codes 2 and 3) gave 74 to 87% control which is normal. Off-Shoot-T at the button stage followed by MH or FST-7 at topping will give 95 to 100% control of both pre- and post-topping suckers and will last for 5 to 6 weeks after topping.

Royal MH-30 and RMH-30 soluble granules resulted in 99 and 98% control respectively (Treatment 4, Code 2 and 3).

Fair Plus and Fair 2, when used at the same rate of active ingredient, were equally effective (99 and 100%, Treatment 7, Codes 2 and 3).

Prime Plus alone (Treatment 6) or tank mixed with OST (Treatment 5, Code 3) was very effective. A few skips were present in all tests.

FST-7 used alone at 9 quarts per acre (Treatment 8) or used at 8 quarts following a contact (Treatment 5, Codes 1 and 2) was very effective. However, one location in Code 2 was adversely affected by rain.

Yields in the sucker control tests were erratic this year. Differences can be attributed more to degree of water injury from excess rainfall than to differences among the sucker control chemicals.

Sucker Control Treatments 1984

Code 1

1. Topped, not suckered until harvest
2. Fair 85 @ 1 1/2 GPA button plus Bud Nip @ 1 GPA at topping
3. OST @ 1 1/2 GPA early button + 1 1/2 GPA late button plus RMH @ 2 GPA at topping
4. Fair + @ 2 GPA at topping
5. Fair 85 @ 1 1/2 GPA button plus FST-7 @ 2 GPA at topping
6. Prime + @ 1 GPA at topping
7. OST @ 1 1/2 GPA button + RMH @ 2 GPA at topping
8. FST-7 @ 9 quarts per acre at topping

Code 2

1. Topped, not suckered until harvest
2. OST @ 1 1/2 GPA button plus Bud Nip @ 1 GPA at topping
3. OST @ 1 1/2 GPA button plus 1 1/2 GPA at topping
4. RMH-30 @ 2 GPA at topping
5. Fair 85 @ 1 1/2 GPA button plus FST-7 @ 2 GPA at topping
6. Prime + @ 1 GPA at topping, hand sucker as needed
7. Fair 85 @ 1 1/2 GPA button plus Fair + @ 2 GPA at topping
8. FST-7 @ 9 quarts per acre at topping

Code 3

1. Topped, not suckered until harvest
2. OST @ 1 1/2 GPA button plus Bud Nip @ 1 1/2 GPA at topping
3. OST @ 1 1/2 GPA button plus 1 1/2 GPA at topping
4. RMH-30 soluble granules @ 3 lbs Al/A
5. OST @ 1.5 GPA plus Prime + @ 1 GPA tank mix at button
6. Prime + @ 1 GPA at topping
7. Fair 85 @ 1 1/2 GPA button plus Fair 2 @ 3 lbs Al/A at topping
8. FST-7 @ 9 quarts/A at topping

Sucker Control 1984

Nave Campbell - Mitchell County
Code 1

Tmt.No.	% Control	Suckers no/pl	Gn.Wt. gms/pl	Acre Yield	$/cwt	$/A
1	--		28	2353	185.40	4363
2	100		0	2040	184.47	3763
3	100		0	1995	185.81	3708
4	96		1	1995	185.67	3704
5	100		0	2258	185.75	4194
6	75		7	2130	185.07	3945
7	96		1	1931	185.63	3585
8	100		0	2085	185.82	3875

1st application 8/16
2nd application 8/21
sucker cleanup 9/5

Sucker Control 1984

2 Locations
Code 2

Tmt.No.	% Control	Suckers no/pl	Gn.Wt. gms/pl	Acre Yield	$/cwt	$/A
1	--	6.4	774	2194	186.21	4079
2	99	0.3	8	2720	185.11	5032
3	87	1.8	99	2741	185.57	5085
4	99	0.2	4	2634	185.61	4889
5	97	0.6	22	2829	186.42	5274
6	97	0.9	25	2539	185.60	4771
7	99	0.2	2	2464	185.68	4570
8	89	0.6	83	2462	185.63	4572

Sucker Control 1984

2 Locations
Code 3

Tmt.No.	% Control	Suckers no/pl	Gn.Wt. gms/pl	Acre Yield	$/cwt	$/A
1	--	6.5	590	2351	170.95	3926
2	99	0	1	2634	175.40	4532
3	74	2.4	152	2389	172.06	4009
4	98	0.3	10	2727	171.14	4577
5	99	0.2	2	2695	171.50	4505
6	88	0.6	73	2802	171.23	4718
7	100	0	0	2514	171.78	4203
8	99	0.1	1	2899	170.35	4838

On-Farm Variety Tests 1984

Data are presented for tests located in Haywood, Macon, Mitchell, and Jackson Counties. Although dry conditions were encountered during transplanting and harvesting, most of the actual growing season had rainfall above normal. Leaf from a wet weather crop is thin in body and weighs somewhat lighter than that grown in a slightly drier season. Overall, yields are lower than those obtained in the last two or three years but are still respectable.

Kentucky 10 had excellent yields and a good selling price. It has always been a high yielder but has never become popular among North Carolina growers because of curing problems that occur in some seasons. Growers that like the Kentucky 10 type will usually select the hybrid, Burley 21 x Kentucky 10, because of greater ease in curing and yields are generally similar.

Kentucky 14 and Kentucky 15 were similar in yield and selling price. Kentucky 14 has been the most popular variety in the state for several years. It seems to mature a little faster than Kentucky 15 after topping.

The black shank resistant varieties, Burley 64, Kentucky 17, Virginia 509, and Virginia 528 are in the moderate yielding category.

Burley hybrids are very popular over the entire burley belt. Sometimes they will exceed the straight line high yielding parent by a small amount and sometimes they will be lower yielding. Most burley plant breeders do not consider the hybrids to have heterosis or hybrid vigor.

The slight differences in selling prices are probably more a reflection of water injury during the growing season than a real difference among the varieties. No significant differences in selling price have been detected among burley varieties or hybrids over the past several seasons.

Acre yields, value per hundredweight (based on 1984 advance), and acre values are given in the following table.

4 Locations

Variety	Acre Yield	$/cwt	$/A
1. Ky 14	2619	178.73	4680
2. Ky 15	2534	178.59	4530
3. Ky 10	2848	181.37	5168
4. Bu 64	2297	178.66	4103
5. Ky 17	2303	179.22	4125
6. Va 509	2464	180.42	4441
7. Ky 14 x L8	2342	179.33	4187
8. Bu 21 x Ky 10	2556	180.33	4598
9. Va 528	2498	180.45	4522
10. Bu 21 x Ky 14	2495	181.37	4524

Curing With Supplemental Heat

Supplemental heat was used very little during the 1984 curing season. Dry weather prevailed throughout harvesting and for most of the curing period; one rainy period lasting for a week or ten days occurred near the end of curing but had little effect on yield or quality in these tests.

The advantages of supplemental heat are more apparent during seasons when inclement weather prevails for much of the curing period. Damage from houseburn on burley tobacco usually does not begin until the leaf has passed through the yellowing stage of the cure. Even then, very little injury is apparent unless humidity at or near 100% lasts for 24 hours or longer. Severe damage can be expected when rainy weather, fog, and high humidity lasts for several days. The organisms that cause houseburn - several species of fungus, bacteria, and probably yeasts - occur naturally on tobacco leaves. They are much more active during periods of high humidity or when a film of moisture is present. Heat is used sparingly with just enough being applied to raise the barn temperature by only 6-8 degrees fahrenheit. This is usually sufficient to lower humidity enough to inactivate the harmful organisms. Higher temperatures will set undesirable colors in the leaf.

Houseburn has many common names in different sections of the burley belt. It may be referred to as barn rot, pole rot, pole sweat, stem rot, barn sweat, house sweat, white mold, gray mold, brown mold, white stalk mold, or leaf rot. In any event, all experienced burley producers are familiar with it by one name or another.

Results from the 1984 tests at two locations are given in the accompanying table.

2 Locations

Treatment	Yield	$/cwt	$/Acre
No Heat	2949	180.61	5310
Heat	2933	180.44	5287

Title: NC 3835 Explanation of Size Distribution of Farms: Economic Models and Empirical Applications

Project Leader: Daniel A. Sumner

I. Summary of Research:

During the past year we have made significant progress developing data bases and summarizing recent patterns in the size of tobacco farms and enterprises. The publications that represent this research are cited below. They contain information on the influence of policy changes on the structure of the tobacco industry and descriptions of size distributions using acres, pounds, sales of tobacco and total farm sales for tobacco farms in both burley and flue-cured regions.

The 1982 Census of Agriculture has only recently become available and research assistants have been using this source at the county level to separate flue-cured and burley data in states like North Carolina and Virginia that grow both types. This will allow us to develop information on characteristics for farms that grow both burley and flue-cured tobacco. This is not available from any other source.

We have also begun to analyze evidence on the potential market supply function for the flue-cured tobacco production industry. The method involves inverting a function that represents the lease rate a farmer is willing to pay for quota to derive the implied sensitivity of marginal costs to underlying conditions.

IIB. Undergraduate Research Assistants:

W. Bennett Bradley and D. Arthur Sparrow

IV: Publications:

A. Research Publications

Sumner, D. A., and Alston, J. M. 1984. "The Impact of Removal of Price Supports and Supply Controls for Tobacco in the United States." In: Research in Domestic and International Agribusiness Management, Vol. 5, 1984, pp. 107-164. See especially section 2.7.

Sumner, D. A. 1985. "Structural Consequences of Commodity Programs." American Enterprise Institute for Public Policy Research, January 1985.

VII.

IX.

Hoover, D. M., and D. A. Sumner. "Tobacco and Peanut Policy Options: 1985 and Beyond," in Alternative Agricultural and Food Policies and the 1985 Farm Bill. Conference Proceedings, Giannini Foundation, 1984.

Sumner, D. A., and J. M. Alston. Consequences of Elimination of the Tobacco Program. North Carolina Agricultural Research Service Bulletin No. 469, March 1984.

B. Popular and Extension Publications

Sumner, D. A., and Julian M. Alston. "The Tobacco Program: Where Would You Be Without It?" Flue-Cured Tobacco Farmer, March 1984, pp. 34-39.

VII. Papers Presented at Professional Meetings:

Sumner, D. A., and D. A. Sparrow. "Size Distributions of Tobacco Farms and Enterprises," 31st Tobacco Workers Conference, forthcoming in a Proceedings, 1985.

Sumner, D. A. "Farm Programs and Structural Issues." American Enterprise Institute Conference on U.S. Agricultural Policies, Washington, D. C., January 28-29, 1985, forthcoming in a Proceedings.

IX. Acknowledgements:

M. Kowalski, J. Leiby and E. Newton each provided assistance to this project.

Title: Analysis of Demand for Tobacco and Tobacco Products

Project Leader: Daniel A. Sumner

I. Summary of Research:

Demand changes for U.S. tobacco in the domestic market has two sources: (1) changes in the demand for cigarettes, (2) changes in the use of U.S. tobacco relative to other inputs. Both of these factors are important to the U.S. tobacco industry.

Our recent time series econometric analysis of cigarette demand at the wholesale level yields own price elasticities in the rante of -0.3 with a positive but small income effect after correcting for first and second order auto-regression to errors. Cross-section time-series estimation using variation across states as well as over years allowed us to examine price and income effects conditional on a rich set of demographic variables. These results suggest a negative effect of schooling on cigarette demand but significant income elasticity. Price effects that include illegal bootlegging are quite elastic (below -1.0). When tax rate differentials are included in the model, however, retail and price elasticities for cigarettes are about -.5.

We find surprisingly large substitutibility of U.S. tobacco for imported tobacco and other inputs in our estimation of a system of input demand equations based on the U.S. cigarette manufacturing industry. A variety of specifications all yield output constant own price elasticities of about -2.0 for domestic tobacco. Imports and other inputs are statistically significant substitutes for U.S. tobacco in these equations.

Other recent research has focused on using our basic supply and demand parameter estimates to study storage and variability, and other implications of policy change in the tobacco industry.

IIA. Graduate Students:

Ruey-er Chang

IIB. Undergraduate Research Assistants:

W. Bennett Bradley and Marianne Kowalski

IV. Publications:

A. Research Publications

Sumner, D.A. and J.M. Alston. The Effects of the Tobacco Program in the U.S.: An Analysis of Decontrol, AEI

Occasional Papers, American Enterprise Institute for Public Policy Research, Washington, D.C., November 1984.

B. Popular and Extension Publications

Sumner, D.A. "Tobacco, Farm Policy and the Marketplace," Tar Heel Economist, May 1984.

Sumner, D.A. "Tobacco Deregulation Would Result in Lower Prices, Increased Output," Tobacco International, March 16, 1984, pp. 26-28.

V. Manuscripts Accepted for Publication:

Sumner, D.A. and M. Wohlgenant. "Effects of an Increase in the Federal Excise Tax on Cigarettes," American Journal of Agricultural Economics, forthcoming, Vol. 85, No. 2, May 1985.

VI. Manuscripts in Review

Sumner, D.A. and J.M. Alston. "The Demand for U.S. Tobacco: Econometric Estimation and Interpretations." Submitted as an annual meetings selected paper to the American Agricultural Economics Association.

Alston, J.M. and D.A. Sumner. "Variability of Farm Prices in an Unregulated Market: Projections of Case for U.S. Tobacco." Submitted as an annual meetings selected paper to the American Agricultural Economics Association.

VII. Papers Presented at Professional Meetings:

Sumner, D.A. "An Econometric Analysis of the Interstate Demand for Cigarettes, Including the Demand to Smuggle," 31st Tobacco Workers Conference, forthcoming in a Proceedings, 1985.

IX. Acknowledgements:

J.M. Alston, E. Newton and D.A. Sparrow each provided assistance to this project.

Title: NC 02105 Analysis of International Trade Restrictions

Project Leader: Paul R. Johnson

I. Summary of Research:

Flue-cured tobacco continues to be one of the commodities studied under this project. In 1984 the book shown under item IV was published. One of the objectives of that book was to bring together some of the published and unpublished work on tobacco done in the Department of Economics and Business over the last twenty years or so. Some of the areas covered in some depth are: the history and analysis of the Supply Control program, mechanization and its effect on labor markets, the demand for tobacco including health effects, the taxation of tobacco.

The importation of foreign tobacco is a potential continuing problem for domestic producers. One dimension of this problem is a perceived change in quality of domestic leaf. Work has been started on an economic analysis of this problem. The analysis examines stabilization receipts by grade in an attempt to see whether there has been a systematic change over time by grade.

IV. Publications:

Johnson, Paul R., 1984. The Economics of the Tobacco Industry, Praeger Publishers, New York, N.Y.

Title: Tobacco Insect Control: NC3671

Project Leader: Emmett P. Lampert

I. Summary of Research:

A. Evaluation of insecticides for control of insect pests.

Experiments were conducted at the Border Belt Tobacco Research Station, Central Crops Research Station, and the Upper Piedmont Research Station to determine the efficacy of soil and foliar-applied insecticides against insects in flue-cured tobacco. All experiments were set up in a randomized complete-block design with either three or four replicates. Plots were generally 4 rows (3.75' on center), 60 to 80' in length. Treatments were applied using a John Deere Hy-Cycle 600 sprayer at a rate of 25 gallons per acre and 60 psi. Broadcast granular materials were applied with a Gandy granular applicator mounted on a Kubota tractor. Treatments were incorporated within 1 hour after application with a tandom disc and ridged within 24 hours. Transplant water treatments were applied at a rate of 145 gallons of water per acre. Evaluations were made for efficacy against tobacco hornworms, tobacco budworms, tobacco flea beetles, tobacco wireworms, and green peach aphids. These experiments were set up in tests containing from 3 to 14 treatments, and many were repeated twice during the season. Because of this complexity and bulk, a reader is referred to "Chemical tests in flue-cured tobacco in 1984" for the efficacy of specific materials against specific insects.

B. Laboratory evaluation of insecticides, fungicides, and sucker control chemicals for control of sooty mold and flue-cured tobacco.

Honeydew excreted by green peach aphids, Myzus persicae (Sulzer), feeding on tobacco collects on the upper leaf surface of leaves below the aphid colonies. The accumulated honeydew is a substrate for the growth of sooty mold. Sheets of tobacco are graded lower by USDA inspectors when the tobacco is infested with sooty mold. There are currently no recommendations for control of sooty mold on tobacco in North Carolina (Powell and Shoemaker 1984). The objective of this study was to determine whether sooty mold could be controlled by selective use of chemicals already registered for use on tobacco in North Carolina.

The test chemicals were added to potato dextrose agar in Petri dishes at concentrations sufficient to produce a rate of 20,000 μg AI/ml (4 replications/treatment). This rate was chosen for initial screening of the chemicals because it was higher than the recommended field rate for most of the chemicals. Test plates were inoculated with sooty mold spores (Cladosporium herbarum (Pers.)Link ex S.F. Gray) and placed in the dark at room temperature (ca. 24°C). The plates were checked for growth and sporulation of the fungus at 3, 4, 5, 6, and 9 days.

The chemicals that prevented growth and sporulation of the fungus were three insecticides: monocrotophos, endosulfan, and methomyl; three fungicides: mancozeb, metalaxyl, and benomyl; and two sucker control chemicals: Prime +® and Offshoot-T®. Benomyl is not registered for use on tobacco in North Carolina; however, it was included in these tests because it reduced the amount of sooty mold on tobacco in field plots (Lampert, unpublished data). There was hyphal growth and sparse sporulation in plates containing the insecticides acephate and carbaryl. There was dense growth and sporulation in plates containing the insecticides Diazonon® and Dipel® (Bacillus thuringiensis); the bactericide streptomycin sulfate; the sucker control chemical maleic hydrazide; and the control (water).

The chemicals that prevented growth and sporulation of the fungus in the initial test were tested at a range of dosages that included the recommended field rate. These plates were checked for growth and sporulation of the fungus daily for three weeks, and then once each week for an additional four weeks. No sporulation occurred within 49 days in plates containing mancozeb, benomyl, or Offshoot-T® at dosages below the field concentration (Table 1).

Monocrotophos, endosulfan, methomyl, and metalaxyl were effective in preventing growth and sporulation at 10,000 µg AI/ml, but not at 1,000 µg AI/ml. The recommended field rate for these chemicals is between 1,000 and 10,000 µg AI/ml; therefore, an additional test was conducted to determine whether these chemicals were effective at the recommended field rates. Only metalaxyl prevented growth and sporulation of the fungus at the recommended field rate (Table 2).

In this preliminary study, three fungicides - mancozeb, metalaxyl, and benomyl, and a sucker control chemical - Offshoot-T® prevented growth and sporulation of the sooty mold fungus at current field application rates. The results of these studies may help a grower in deciding which chemical to use when faced with more than one control problem.

Reference

Powell, N.T., and P.B. Shoemaker. 1984. Tobacco disease control, pp. 166-167. In N.C. Agriculture Chemicals Manual. School of Agric. & Life Sciences, N.C. State University, Raleigh.

Table 1. Day first sooty mold spores were produced on potato dextrose agar treated with various protectant chemicals at several dosages, first test

Table 1. Day first sooty mold spores were produced on potato dextrose agar treated with various protectant chemicals at several dosages, first test

Treatment	Mean Days to Sporulation (SE)[a]								
	Dosage (μg AI/ml)								
	0	1	10	100	1,000		10,000	20,000	
Insecticides									
Azodrin	3.5(0.3)	2.0(0.0)	2.3(0.3)	2.8(0.3)	4.0(0.0)	FR[b]	-[c]	-	
Orthene	3.0(0.0)	2.3(0.3)	3.0(0.0)	3.0(0.0)	3.0(0.4)	FR	4.5(0.5)	-	
Thiodan	2.0(0.0)	2.0(0.0)	2.3(0.3)	2.3(0.3)	5.5(0.9)	FR	-	-	
Lannate	3.0(0.4)	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.8(0.3)	FR	-	-	
Sevin	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.0(0.0)	3.0(0.0)	FR	3.3(0.3)	3.0(0.0)	
Fungicides									
Manzate	2.0(0.0)	2.0(0.0)	3.0(0.0)	-	-	FR	-	-	
Ridomil	2.3(0.3)	2.3(0.3)	2.0(0.0)	2.0(0.0)	13.0(7.4)	FR	-	-	
Benlate	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.5(0.3)	-	FR	-	-	
Sucker Control Chemicals									
Prime+	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.0(0.0)	FR	9.8(0.3)	12.3(1.8)	
Offshoot-T	2.0(0.0)	2.0(0.0)	2.0(0.0)	2.8(0.3)	-	-	-	-	FR

[a]The test plates for the chemicals were set up over a period of several days. Therefore, mean days to sporulation can not be compared between chemicals. N=4 for all means.

[b]Recommended field rate. (Azodrin - 2,622 μg AI/ml; Orthene - 2,397; Thiodan - 2,397-4,794; Lannate - 2,157; Sevin - 4,794-9,587; Manzate - 5,752-7,670; Ridomil - 3,995-7,989; Benlate - 2,497; Prime+ - 2,876; Offshoot-T - 30,010.

[c]No sporulation within 49 days.

Table 2. Day first sooty mold spores were produced on potato dextrose agar treated with various protectant chemicals at several dosages, second test

Days to sporulation[a]											
Azodrin			Thiodan			Lannate			Ridomil		
Dosage (µg AI/ml)	$\bar{x}$	SE	Dosage (µg AI/ml)	$\bar{x}$	SE	Dosage (µg AI/ml)	$\bar{x}$	SE	Dosage (µg AI/ml)	$\bar{x}$	SE
1000	2.0	0.0	1000	3.8	1.0	1000	2.0	0.0	1000	3.0	0.0
2000	2.3	0.8	2000	5.0	0.0	2000	3.0	0.0	2000	18.3	0.9[b]
2622[e]	3.0	0.0	2397[e]	7.5	1.9	2157[e]	3.3	0.3	3000	8.0	-[c]
10000	-	-[d]	3000	7.3	0.3	10000	-	-	3995[e]	-	-
			4000	9.5	2.2				4000	-	-
			4794[e]	8.0	0.0[b]				5000	-	-
			10000	-	-				6000	-	-
									7000	-	-
									7989[e]	-	-
									10000	-	-

[a]N=4 unless otherwise noted. Sporulation occurred in control plates at 2.0 (0.0) days.

[b]Sporulation occurred on only 3 plates (N=3).

[c]Sporulation occurred on only 1 plate (N=1).

[d]No sporulation with 49 days.

[e]Recommended field rate.

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C. Age-specific honeydew production and life history of the green peach aphid (Homoptera: Aphididae) on flue-cured tobacco.

Green peach aphids (GPA) can reduce the quality of tobacco (Mistric and Clark 1979), and GPA transmit several viruses that cause diseases in tobacco (Lucas 1975). In addition, honeydew excreted by GPA accumulates on the upper leaf surfaces of leaves below the aphid colonies, providing a substrate for the growth of sooty mold. Very little is known about the relationship between honeydew production and growth of the sooty mold fungus. The objectives of this study were to determine age-specific honeydew production and life-history parameters of GPA on flue-cured tobacco.

The honeydew recording apparatus used were similar to those described by Banks and Macaulay (1964) with the modifications of Ajayi and Dewar (1982). Honeydew excreted by the aphids fell onto a strip of indicator paper (4 cm wide Whatman No. 1 filter paper stained with a solution of 2 mg bromocresol green/ml of 95% ethanol) and formed distinct spots on the paper.

Four honeydew recording apparatus were placed in a room kept at ca. 24°C under artificial 16:8 h photophase:scotophase. Each apparatus recorded the excretions of 6 aphids. The plants used were 7-leaf "McNair 944" tobacco. Aphids were 0-18 h old (1st instar nymph) at the start of the experiment and were placed on the fourth leaf from the bottom of the plants. Indicator papers were changed and aphid exuviae were removed daily.

Relationship between mean spot diameter and droplet volume

To determine the relationship between mean spot diameter and droplet volume, known volumes of honeydew of 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, and 0.10 μl were spotted onto a strip of indicator paper (10 drops for each volume), and the mean diameter of the spots was measured (means of two measurements of a spot taken at right angles to each other). The relationship between mean spot diameter (mm) and drop volume can be described by the equation (R^2 = 0.98, n=100):

$$\text{Volume} = [(\text{Diam} + 0.347124)/4.897251]^3.$$

Honeydew production

Excretion began on the first day and continued throughout the life of the aphids (Fig. 1). Frequency of excretion decreased shortly before the aphids began to produce nymphs and then increased several days later. Frequency of excretion again decreased as aphids grew older. Aphids excreted throughout the day and night, except when molting. Of the initial 24 aphids in each test, 16 and 22 survived to the adult stage in test 1 and 2, respectively. Mean frequency of excretion was 181.1 drops (SE=29.9) and 197.1 drops (SE=15.5) in two

[e]Recommended field rate.

tests. Mean volume of honeydew drops increased daily until the fourth instar, and then remained fairly constant throughout the adult stage (Table 1).

Life-history parameters

Of the aphids that survived to the adult stages, mean longevity was 13.5 days (SE=1.1) and 15.2 days (SE=0.7) in two tests. Mean number of days before the first nymph was produced was 7.2 (SE=0.2) and 7.9 (SE=0.2) in two tests. Mean number of nymphs produced was 26.6 (SE=4.7) and 21.8 (SE=2.5) in two tests. The net reproductive rate, R_0 (Southwood 1978), was 17.7 and 20.0 in the two tests.

These results indicate that life-history parameters for GPA are similar on burley (Barlow 1962) and flue-cured tobaccos. The data presented on excretion could be useful for determining management strategies for sooty mold on flue-cured tobacco. Once a threshold honeydew level required to support growth of sooty mold is determined, the data reported here could be used to determine the aphid-days (Southwood 1978) required before the threshold honeydew level is reached.

References

Ajayi, O., and A.M. Dewar. 1982. The effect of barley yellow dwarf virus on honeydew production by the cereal aphids, Sitobion avenae and Metopolophium dirhodum. Ann. Appl. Biol. 100: 203-212.

Banks, C.J., and E.D.M. Macaulay. 1964. The feeding, growth and reproduction of Aphis fabae Scop. on Vicia faba under experimental conditions. Ann. Appl. Biol. 53: 229-242.

Barlow, C.A. 1962. The influence of temperature on the growth of experimental populations of Myzus persicae (Sulzer) and Macrosiphum euphorbiae (Thomas) (Aphididae). Can. J. Zool. 40: 145-156.

Lucas, G.B. 1975. Diseases of tobacco. Biological Consulting Assoc., Raleigh, NC.

Mistric, W.J., Jr., and G.B. Clark. 1979. Green peach aphid injury to flue-cured tobacco leaves. Tob. Sci. 23: 23-24.

Southwood, T.R.E. 1978. Ecological methods with particular reference to the study of insect populations. Chapman & Hall, London.

Whalon, M.E., and Z. Smilowitz. 1977. Determination of constant temperature developmental thresholds for Myzus persicae (Sulzer) (Homoptera: Aphididae). J. N.Y. Entomol. Soc. 85: 206.

Table 1. Production of honeydew by green peach aphids on flue-cured tobacco, first test

Day	No. aphids alive	Volume of honeydew/aphid (μl)		Mean volume drop (μl)			Mean instar[b]	Cum. degree days[c]
		$\bar{X}$	SE	$\bar{X}$	SE	n[a]		
1	16	0.13	0.03	0.009	0.000	16	1.0	19
2	16	0.14	0.04	0.012	0.000	15	1.2	39
3	16	0.34	0.07	0.016	0.001	16	1.9	58
4	16	0.40	0.09	0.022	0.002	16	3.0	78
5	16	0.40	0.12	0.031	0.002	15	3.4	98
6	16	0.35	0.10	0.030	0.002	15	3.9	118
7	16	0.22	0.08	0.034	0.004	10	4.8	138
8	16	0.50	0.12	0.034	0.003	14	5.0	156
9	14	0.62	0.19	0.033	0.002	13	5.0	175
10	12	0.52	0.19	0.031	0.002	11	5.0	196
11	11	0.48	0.18	0.034	0.003	10	5.0	220
12	9	0.37	0.18	0.035	0.005	6	5.0	247
13	8	0.41	0.22	0.035	0.004	7	5.0	271
14	8	0.37	0.20	0.033	0.003	7	5.0	292
15	7	0.39	0.16	0.038	0.003	6	5.0	312

Table 1. (continued)

Day	No aphids alive	Volume of honeydew/ aphid (µl)		Mean drop volume (µl)			Mean instar[b]	Cum. degree days[c]
		$\bar{X}$	SE	$\bar{X}$	SE	n[a]		
16	6	0.01	0.01	0.032	0.001	2	5.0	332
17	3	0.12	0.12	0.053	-	1	5.0	351
18	3	0.34	0.25	0.034	0.006	3	5.0	372
19	2	0.06	0.06	0.039	-	1	5.0	392
20	2	0.27	0.20	0.039	0.003	2	5.0	411
21	2	0.09	0.09	0.044	-	1	5.0	431
22	1	0.29	-	0.036	-	1	5.0	449
1-22		4.68	0.88	0.025	0.001	16		

[a]Some aphids did not excrete honeydew every day.

[b]Mean instar = $\left(\sum_{i=1}^{5} iN_i\right) / \sum_{i=1}^{5} N_i$, where Ni = no. aphids in stage $\underline{i}$ (5=adult).

[c]Base = 4°C (Whalon and Smilowitz 1977). Degree days were calculated as mean daily temperature - base temperature.

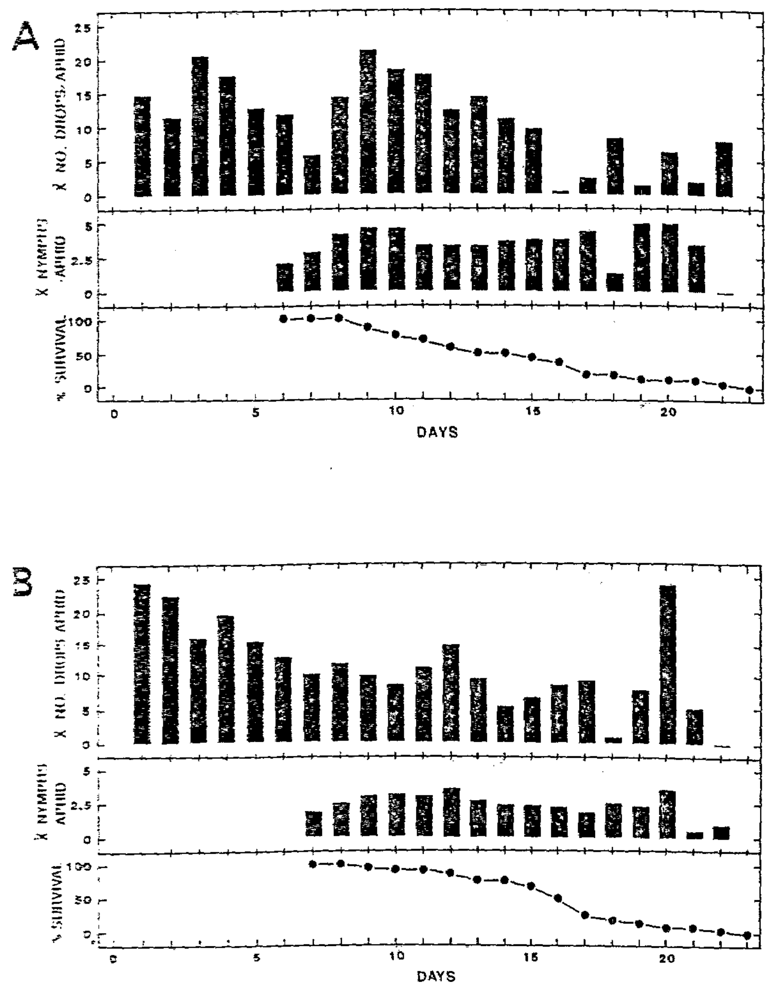

Fig. 1. Survival, fecundity, and frequency of excretion of green peach aphids on flue-cured tobacco at 24°C (A = test 1; B = test 2).

2000269804

II. Graduate Students:

- Committee Chairman - Randi Wilfert (Ph.D.), Mike Duke (M.S.).
- Committee Member - 3 (Ph.D.).

III. Postdoctoral Fellows:

- Dr. James E. Throne, R.J. Reynolds Fellowship

IV. Publications:

Lampert, E.P., D.C. Cress, and D.L. Haynes. 1984. Temporal and spatial changes in abundance of the asparagus miner, Ophiomyia simplex (Loew) (Diptera: Agromyzidae), in Michigan. Environ. Entomol. 13: 733-736.

Margolies, D.C., E.P. Lampert, and G.G. Kennedy. 1984. Sampling program for the twospotted spider mite (Acari: Tetranychidae) in peanut. J. Econ. Entomol. 77: 1024-1028.

Lampert, E.P. 1984. Control of tobacco budworm and tobacco hornworm with Bacillus thuringiensis var. Kurstaki, 1982. Insecticide and Acaricide Tests 9: 321.

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Lampert, E.P. 1984. Control of tobacco budworms and tobacco hornworms with foliar insecticides, 1983. Insecticide and Acaricide Tests 9: 323.

Lampert, E.P., and P.S. Southern. 1984. Control of an uncommon pest attacking flue-cured tobacco, 1982. Insecticide and Acaricide Tests 9: 324.

V. Manuscripts Accepted for Publication:

Lampert, E.P., and D.L. Haynes. (In press). Population dynamics of the cereal leaf beetle, Oulema melanopus (Coleoptera: Chrysomelidae), at low population densities. Environ. Entomol.

Lampert, E.P. (In press). Control of tobacco wireworms and flea beetles with soil and foliar insecticides, 1984. Insecticide and Acaricide Tests 10.

Lampert, E.P. (In press). Control of green peach aphids with side-dress applications of Temik, 1984. Insecticide and Acaricide Tests 10.

VI. Manuscripts in Review

Throne, J.E., and E.P. Lampert. Age-specific honeydew production and life-history of the green peach aphid (Homoptera: Aphididae) on flue-cured tobacco.

2000269805

Throne, J.E., and E.P. Lampert. Laboratory evaluation of insecticides, fungicides, and sucker control chemicals for control of sooty mold on flue-cured tobacco.

VII. Papers Presented at Professional Meetings:

Lampert, E.P. Economic thresholds and scouting techniques. Discussion Leader, Tobacco Seminar, Gatlinburg, TN. March 7, 1984.

Lampert, E.P. Preliminary results of the 1984 tobacco scouting project. 31st Tobacco Worker's Conference, Pinehurst, NC. January 8, 1985.

Lampert, E.P. Discussion: standardization of tobacco scouting techniques. 31st Tobacco Worker's Conference, Pinehurst, NC. January 8, 1985.

Duke, M.E. and E.P. Lampert. The effects of soil insecticides on larval number and first brood adult emergence of the tobacco flea beetle, Epitrix hertipennis (Melsheimer). 31st Tobacco Worker's Conference, Pinehurst, NC. January 8, 1985.

Southern, P.S., and E.P. Lampert. Field evaluation of various insect management approaches in burley tobacco in North Carolina. 31st Tobacco Worker's Conference, Pinehurst, NC. January 8, 1985.

Throne, J.E., and E.P. Lampert. Laboratory evaluation of insecticides, fungicides, and sucker control chemicals for control of green peach aphids and sooty mold on flue-cured tobacco. 31st Tobacco Worker's Conference, Pinehurst, NC. January 9, 1985.

VIII. Graduate Student Thesis Completed During Reporting Period:

Gray, S.M. 1984. The relationship of alate aphids and inoculum source levels on the rate of primary and secondary spread of potato virus Y in tobacco. M.S. thesis, N.C. State Univ., 211 pp.

IX. Acknowledgements:

I would like to acknowledge the technical assistance provided by Mr. Alan Stephenson and Mr. Lawrence Pearce, and the editorial and secretarial assistance provided by Ms. Connie Satterwhite. I would also like to acknowledge the North Carolina Tobacco Foundation for supporting much of this research. The cooperation provided by Mr. George Clark and Mr. Kimbell Brock, Border Belt Research Station; Mr. Wallace Baker and Mr. Alton "Bo" Woods, Central Crops Research Station; and Mr. Howell Gentry and Mr. Darryl Dunagan, Upper Piedmont Research Station, has greatly facilitated the performance of this research.

Title: NC 05573 Management Strategies for Tobacco Insect Pests

Project Leader: D. Michael Jackson

I. Summary of Research:

A. New aqueous-flowable formulations of Bacillus thuringiensis (B.t.) var. kurstaki were tested for efficacy against tobacco budworm and tobacco hornworm larvae on flue-cured tobacco. A liquid formulation containing the β-exotoxin from B.t. was also evaluated. Both of the aqueous formulations were as effective as commerically available Dipel WP at comparable rates for budworm and hornworm control. The β-exotoxin material was not effective when sprayed alone, but when tank mixed with Dipel WP there was a synergistic increase in efficacy. These materials were provided by Abbott Laboratories.

B. Twelve treatment combinations of two sucker control chemicals (Royal MH-30 and Bud Nip) and four insecticides (Sevin, Orthene, Lannate, and Dipel) were tested for the second year for efficacy against tobacco hornworm larvae and sucker control. Neither insecticide activity nor sucker control efficiency were altered by the tank mix combinations. Both sucker control agents gave good control, but Royal MH-30 plots began producing some new suckers before final harvest. However, this late sucker production did not affect yield and quality ratings. None of the treatments caused phytotoxicity.

C. Cone-type traps were baited with a commercial preparation of Virelure that attracts male tobacco budworm moths, and were monitored at Oxford, NC and Tifton, Georgia for the 3rd year. Data will be combined with past and future information on Heliothis captures in order to more accurately predict peak adult population levels. These predictions will be used to better plan field experiments and for determining optimum planting dates for host plant resistance field screening tests.

D. The tobacco insect pest monitoring program was continued. Adult tobacco budworms (males), tobacco hornworms, and tomato hornworms were collected weekly in Granville County, NC from 8 traps each of 3 different types: (1) wire cone traps baited with Virelure, (2) electric grid traps baited with Virelure, and (3) blacklight traps. In addition insect pests were monitored and collected from 10 tobacco fields in Granville County, NC throughout the growing season. Parasite numbers reared from these insects were recorded. This monitoring program has been in continuous operation since 1962. These data are useful in recognizing patterns of pest or beneficial species fluctuations. The importance of certain pest species have changed over the years, which may be correlated to changes in cultural practices of insecticide-use patterns.

E. We maintain laboratory colonies of Manduca sexta, M. quinquemaculata, and Heliothis virescens at the Tobacco Research Laboratory. During 1984 ca. 15 research programs throughout the United States were supported by insects from these cultures. Approximate weekly shipments of 20,000 hornworm eggs, 4,500 hornworm pupae, and 1300 budworm pupae were sent to these cooperators.

F. The dispersal of stilt bugs, Jalysus wickhami Van Duzee, from central release zones (RZ) in flue-cured tobacco fields in Bladen and Granville Counties was investigated for the 3rd year. Releases were made into two fields each week in Bladen Co., and this was repeated for 6 weeks. Two releases were made in one Granville Co. field with 3 weeks between releases. Stilt bugs were reared at Oxford, NC in two large plastic greenhouses on potted tobacco plants and were fed previously frozen tobacco hornworm eggs. Adults were collected into plastic shoe boxes with 200 insects per container and stored overnight at 55°F. The following mornings 10,000 stilt bugs per field were released into the RZ's which were 6 rows wide and 10 plants long. Bugs were released on every plant in the RZ. Plots radiating from the RZ were set up at regular intervals in 4 directions to 120 m from the RZ. Plots consisted of 10 plants in a row, and these were examined for stilt bugs daily. Three row-boxes covering 3 plants and containing 100 stilt bugs each were set up in each field. Every 3 days after release one box was examined for insect survival. Preliminary analysis indicates that both stilt bug survival and dispersal rate were dependent on the age of the tobacco in a field. Bugs generally survived better, but dispersed less as the tobacco plants grew larger. Stilt bugs lived on average of three days, and they dispersed an average of 2.4 meters per day for all releases.

G. Fourteen formulations of 12 soil-incorporated or transplant-water-applied insecticides and nematicides were tested for their effects on stilt bugs in a field test for the second year at Oxford, N.C. One hundred stilt bugs were introduced into row boxes containing 3 treated (recommended rate) tobacco plants, and they were left for one week. The boxes were then opened and the stilt bugs were counted. This experiment was repeated for plants 3 and 5 weeks after transplanting. The systemic materials such as Nemacur, Temik, and Vydate were particularly devastating to the stilt bugs (Table 1). Several non-systemic materials had little impact on stilt bug survival.

H. This was the fourth year of an experiment called the "Screening Correlation Test". Sixty-seven tobacco entries were screened over the last 4 years for insect resistance by several methods: (a) field plots of 12-plants at Tifton, Ga. and Oxford, N.C.; (b) oviposition cage tests to determine tobacco budworm ovipositional preference; (c) caged feeding tests of tobacco budworm larvae on intact tobacco seedlings in the field, and (d) feeding tests on potted tobacco seedlings in the greenhouse and laboratory. Leaf surface chemicals also were washed from the leaves of candidate tobaccos with methylene chloride in all tests. Profiles of cuticular waxes from each entry were determined by

Table 1. Survival of stilt bugs placed for one week on tobacco plants treated with soil-incorporated or transplant water pesticides, Oxford, N.C., 1983 and 1984.

Treatment and Formulation	Number of Live Stilt Bugs 3-Wk Experiment	5-Wk Experiment
Parathion 4EC SI [2]	22.3 a [1]	35.3 a
Lorsban 4E SI	21.5 a	24.3 ab
Diazinon 14G SI	15.3 ab	37.2 a
Dasanit 6SC SI	14.7 ab	31.5 ab
Mocap 10G SI	14.5 ab	26.0 ab
Dyfonate 4EC SI	14.5 ab	22.0 abc
Diazinon 50WP TPW [2]	14.3 ab	17.2 bc
Di-Syston 8 SI	13.0 ab	21.0 abc
Check	11.8 ab	23.9 ab
Mocap 6EC SI	10.7 b	30.3 ab
Furadon 4F SI	5.0 c	20.8 c
Orthene 75S TPW	4.7 c	29.7 ab
Vydate L TPW	4.7 c	21.3 ab
Temik 15G SI	1.7 d	4.7 d
Nemacur SC3 SI	0.7 d	5.3 d

[1] Means in the same column followed by the same letter are not significantly different (P=0.05), Waller-Duncan K-ratio t-test.

[2] SI = Soil incorporated
TPW = Transplant water

co-workers at the Russell Research Laboratory, USDA, ARS, Athens, Ga. Quantitative levels of individual chemicals were then correlated to indices of resistance determined from various screening tests. There was a strong correlation (R^2=0.85) between the number of tobacco budworm eggs laid on the test entries and the logarithm of the level of total duvanes found on their leaf surfaces. The duvanes are composed primarily of α- and β-4,8,13-duvatriene-1-ols and α- and β-4,8,13-duvatriene-1,3-diols. Additional samples in 1984 were taken to determine alkaloid levels of these tobacco entries. Data from feeding tests will be analyzed to see if any correlations exist between alkaloid levels and larval survival.

I. Eighteen isogenic tobacco entries varying in levels of total alkaloids were grown in three replications at Oxford, N.C. These plants were sampled for total alkaloid levels every two weeks from plant bed to harvest. At weeks 6 and 8 plants were infested with one tobacco budworm larva per plant then covered with perforated plastic bags. After one week all surviving larvae were collected and weighed.

Relationships between alkaloid levels and larval survival and weight gain are being analyzed. Preliminary analyses indicate no relationship between budworm survival or weight gain and levels of total alkaloids found in these tobaccos.

J. Duvane diterpenes removed from the leaves of a commercial tobacco cultivar were tested further for their influence on the ovipositional response of tobacco budworm moths. A series of 10 oviposition cages (2.4 x 2.4 x 2.0 m) were utilized for several experiments in which duvanes were sprayed onto nonhost plants. These studies showed that the duvane diterpenes stimulated budworm egg laying onto sprayed sweet corn, lima beans, and two Nicotiana species that are not normally selected for oviposition. In other tests, a dosage-response relationship between levels of duvane diterpenes and numbers of eggs laid was developed. Other experiments on Heliothis behavior within these cages indicated that moths detect duvanes only over short distances or on contact with the leaf.

K. Nine Nicotiana species were examined for their response to ovipositing tobacco budworm moths in screen cages. Four test plants were paired against four NC 2326 control plants in cages with ten female moths. Twelve replications were run for each N. spp. Nicotiana excelsior, N. glauca, N. knightiana, and N. solanifolia were especially resistant to budworm oviposition (Table 2).

Table 2. Tobacco budworm oviposition on potted Nicotiana spp. plants in choice tests with NC 2326 flue-cured tobacco, Oxford, N.C., 1984

Nicotiana spp.	Percent of Eggs on Test N. spp.
N. benthamiana	47.2
N. excelsior	1.2 **
N. glauca	0.0 **
N. glutinosa	54.0
N. gossei	27.0 **
N. knightiana	9.5 **
N. solanifolia	7.1 **
N. sylvestris	58.5
N. tomentosiformis	40.4

** significantly different ($P<0.01$) from control, paired t-test.

L. Studies were initiated on tobacco hornworm, Manduca sexta L., ovipositional response to various tobacco entries. These tests were done in large (2.5 x 5.0 x 2.0 m) outdoor cages. Preliminary results indicate there are significant differences between the numbers of eggs laid on some tobacco entries when compared to a normal flue-cured type.

IV. Publications:

Jackson, D. M. 1984. Control of insects on flue-cured tobacco with Bacillus thuringiensis var. kurstaki spray formulations, 1983. Insect. Acar. Tests 9:318-319.

Jackson, D. M. 1984. Insect and sucker control with tank mix combinations of four insecticides and two sucker control chemicals on flue-cured tobacco, 1983. Insect. Acar. Tests 9:319-320.

Jackson, D. M. and E. R. Mitchell. 1984. Growth and survival of tobacco budworm (Lepidoptera:Noctuidae) larvae on Florida beggarweed (Fabaceae) and tobacco (Solanaceae). J. Econ. Entomol. 77:960-965.

Jackson, D. M. and R. F. Severson. 1984. Stimulatory effects of tobacco leaf surface chemicals on tobacco budworm oviposition. 38th Tob. Chem. Res. Conf., Abstract No. 13. (Abstract).

Jackson, D. M., R. F. Severson, A. W. Johnson, J. F. Chaplin, and M. G. Stephenson. 1984. Ovipositional response of tobacco budworm moths (Lepidoptera:Noctuidae) to cuticular chemical isolates from green tobacco leaves. Environ. Entomol. 13:1023-1030.

Jackson, D. M., F. C. Tingle, and E. R. Mitchell. 1984. Survey of Heliothis spp. larvae found on Florida beggarweed and post-harvest tobacco in Florida. Fla. Entomol. 67:130-141.

Severson, R. F., R. F. Arrendale, O. T. Chortyk, A. W. Johnson, D. M. Jackson, G. R. Gwynn, J. F. Chaplin, and M. G. Stephenson. 1984. Quantitation of cuticular components of green tobacco leaf. J. Agric. Food Chem. 32:566-570.

V. Manuscripts Accepted for Publication:

Jackson, D. M. 1985. Efficacy of tank mix combinations of insecticides and sucker control chemicals on flue-cured tobacco, 1984. Insect. Acar. Tests 10: (in press).

Jackson, D. M. 1985. Control of tobacco insect pests with Bacillus thuringiensis var. kurstaki and β-exotoxin of B.t., 1984. Insect. Acar. Tests 10: (in press).

Jackson, D. M., J. J. Lam, Jr., C. M. Knott, and A. H. Baumhover. 1985. Dispersal of laboratory-reared spined stilt bugs in flue-cured tobacco. Proc. Entomol. Sec., 31st Tobacco Workers Conf. (in press).

Jackson, D. M., R. F. Severson, and G. R. Gwynn. 1985. Resistance of tobacco entries to damage by tobacco budworm larvae as measured by laboratory and field feeding experiments. Proc. Entomol. Sec., 31st Tobacco Workers Conf. (in press).

Severson, R. F., R. F. Arrendale, M. E. Snook, V. A. Sisson, D. M. Jackson, and A. W. Johnson. 1985. The green leaf chemistry of insect-resistant Nicotiana species. Proc. Entomol. Sec., 31st Tobacco Workers Conf. (in press).

VI. Manuscripts in Review:

Jackson, D. M., J. F. Chaplin, R. F. Severson, and M. G. Stephenson. 1985. Cuticular leaf chemistry and insect resistance of three reciprocally grafted tobacco types. J. Econ. Entomol. (submitted)

Jackson, D. M., R. F. Severson, A. W. Johnson, and G. A. Herzog. 1985. Effects of cuticular duvane diterpenes from green tobacco leaves on tobacco budworm (Lepidoptera:Noctuidae) oviposition. J. Chem. Ecol. (submitted)

VIII. Papers Presented at Professional Meetings:

Andrews, G. L., D. M. Jackson, R. G. Luttrell, J. R. Phillips, and W. F. Kitten. 1984. Insecticidal and insect growth regulator control of Heliothis: Treatment thresholds. Paper presented at 1984 S-59 Workshop "Theory and Tactics for Heliothis Management. II. Insecticidal and insect growth regulator control of Heliothis." March 13, 1984, Stoneville, Miss.

Jackson, D. M. and J. J. Lam, Jr. 1985. Mortality of spined stilt bug, Jalysus wickhami Van Duzee, on tobacco treated with soil-incorporated insecticides and nematicides. Paper presented at 59th Annual Meeting of the Southeastern Branch of the Entomological Society of America, Jan. 28-31, 1985, Greenville, S.C.

Jackson, D. M., J. J. Lam, Jr., C. M. Knott, and A. H. Baumhover. 1985. Dispersal of laboratory-reared spined stilt bugs in flue-cured tobacco. Paper presented at 31st Tobacco Workers Conference, Jan. 7-10, 1985, Pinehurst, N.C.

Jackson, D. M., R. F. Severson, and G. R. Gwynn. 1985. Resistance of tobacco entries to damage by tobacco budworm larvae as measured by laboratory and field feeding experiments. Paper presented at 31st Tobacco Workers Conference, Jan. 7-10, 1985, Pinehurst, N.C.

Jackson, D. M., R. F. Severson, A. W. Johnson, M. G. Stephenson, and G. A. Herzog. 1984. Tobacco budworm ovipositional response to the cuticular components from green tobacco. Paper presented at 38th Tobacco Chemists' Research Conference, Nov. 5-8, 1984, Atlanta, Ga., Abstract No. 13.

Severson, R. F., R. F. Arrendale, M. E. Snook, V. A. Sisson, D. M. Jackson, and A. W. Johnson. 1985. The green leaf chemistry of insect-resistant Nicotiana species. Paper presented at 31st Tobacco Workers Confrence, Jan. 7-10, 1985, Pinehurst, N.C.

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